DOCUMENT RESUME

ED 129 312 | IR 004 097

AUTHOR	Longo, Alexander A.
TITLE	Guidelines for Optimum Utilization of Computerized Training Systems as Based on an Analysis and Evaluation of Such Programs in the U.S. Army.
PUB DATE	76
NOTE	176p.; Ed.D. Research Project, Nova University
EDRS PRICE	MF-$0.83 HC-$10.03 Plus Postage.
DESCRIPTORS	Comparative Analysis; *Computer Assisted Instruction; Doctoral Theses; Educational Programs; Facility Utilization Research; Feasibility Studies; Guidelines; *Instructional Systems; *Military Training; *Program Effectiveness; Program Evaluation
IDENTIFIERS	IBM 1500 Instructional System; PLATO IV

ABSTRACT

To develop guidelines for the optimum use of computerized training systems in the Army, data related to computer based training were analyzed, including the results of a feasibility study and the results of comparative studies on student achievement, attrition, and attitudes. Three issues were addressed: (1) the effectiveness of computer based education (CBI) versus conventional instructional methods; (2) the comparison of two computer systems (IBM 1500 and PLATO IV); and (3) identification of problems unique to CBI. This report includes a review of relevant literature, background information on the study, a description of research methodology, and a summary of recommendations. (EMH)

ED129312

Guidelines for Optimum Utilization of Computerized Training Systems as Based on an Analysis and Evaluation of Such Programs in the U. S. Army

ALEXANDER A. LONGO

A MAJOR APPLIED RESEARCH PROJECT
PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF EDUCATION

NOVA UNIVERSITY

1976

IR004097

Dedicated

to

June
Alex
Charles
Darryl

This project could not have been completed without the moral support and devotion to duty of my wife and typist, June, and my children, Alex, Charles and Darryl who, though too young to understand the demands upon my time which this project took, were very patient and understanding. I am grateful to them particularly and so many others, family members and close colleagues, for their incentive to make this possible.

ABSTRACT

The purpose of this Major Applied Research Project was to develop guidelines and recommendations for optimizing the utilization of computerized training systems through the conduct of an intensive analysis and evaluation of the Army's empirical data base related to computer-based training. Including a feasibility study, a number of in-house investigations yielded a plethora of data concerning the impact of computer-based instruction (CBI) on student achievement, attrition, attitudes and other performance criteria. This data was derived from several tests and evaluation of two different computer-based instructional systems: the IBM 1500 Instructional System and the PLATO IV Computer-based Educational System. The former system was located completely on site; the latter consisted of PLAto IV terminals which were interfaced via telecommunication link with a large central processor at the University of Illinois. Emphasis in the analysis and synthesis of the data was focused on their operational implications for optimum use of such systems.

Three major issues, with a number of associated questions, were addressed in this project. Issue A pertained to the replicability of effectiveness as regards CBI vs CI (computer-based vs conventional instruction); Issue B pertained to the replicability of effectiveness as regards $CBI_{(1)}$ vs $CBI_{(2)}$ (the two subject CBI Systems considered); and, Issue C pertained to the factors and relationships unique to CBI. Apropos each of these issues and their subsidiary questions, emphasis was placed on: immediate inferences (stated as guidelines) relevant to optimizing CBI operationally; and,

heuristic CBI aspects (stated as recommendations) suggesting further required research.

The procedures and methodology for assessing the above major issues and their allied questions engaged more than one method of research. Overall, the naturalistic training setting was kept intact, and the general research methodology was quasi-experimental. This was particularly the case for Issues A/B, considering the operational context of the two CBI systems. However, Issue C appropriately engaged the correlational method (utilizing both simple/multiple regression) in determining relationships unique to CBI. The information sources for this project consisted of the data bank of information derived from an initial feasibility study and six follow-up CBI studies conducted in-house by this writer. In their entirety, these studies contained a representative cross section of Army enlisted students, Military Occupational Specialties, and technical course material. A variety of CBI effectiveness criteria were employed including: achievement (written/performance), attrition, time-to-complete and attitude.

Statistical analysis regarding the above major issues and their related questions consisted of an array of descriptive and inferential statistics as the respective independent-dependent variables dictated. Included, as appropriate, were the standard descriptive statistics; the classic parametric nonparametric tests of statistical significance; and indices of simple and multiple regression.

Based on a series of investigations, the results on Issue A, pertaining to a test of the replicability of CBI (consisting of computer assisted instruction mostly with some computer managed instruction) as compared to conventional instruction (CI), were highly positive for CBI. Without any equivocation, the basic findings in the Army's initial CBI feasibility study, comparing CAI/CMI with CI, were replicated across several interim and a final summative evaluation, The findings were: that CBI students demonstrated equivalent or greater achievement, on average, than CI students and attained this in significantly less time. Secondly, the results on Issue B, regarding student attitudes/opinions toward CBI, were likewise highly positive toward CBI. The overall finding of the general-specific attitude results was that CBI was significantly favored by students for training purposes. Further, a number of substantive and constructive comments were elicited from students on a broad array of CBI parameters. Lastly, the results on Issue C, pertaining to factors and relationships indigenous to CBI, consistently supported the value of multiple regression analysis as a valuable tool for maximizing predictions of training performance/success. Also, the recurring identification of attitude toward CBI as an added predictor of performance underscored its value in CBI.

Based on the results and experiences of this project, 22 operational guidelines and 17 research recommendations were derived for purposes of optimizing the use of CBI. Both the guidelines and recommendations addressed a variety of general/specific topics of current operational interest: physical learning conditions, instructional methodology, instructor support, student motivation/performance, peer/individual learning and computer generated graphics. The research recommendations represent heuristic considerations on further development and exploration to help bridge the "gap" between the current status of CBI and its future directions. The broader implications of the overall findings of this Major Applied Research Project on CBI are manifold and of significance not just for Tri-service training but across the entire education community.

TABLE OF CONTENTS

SECTIONS Page

SECTIONS Page

LIST OF TABLES

Table		Page

Table | Page

I TITLE

Guidelines for Optimum Utilization of Computerized Training Systems as Based on an Analysis and Evaluation of Such Programs in the U.S. Army

II PURPOSE

The purpose of this project is to develop guidelines and recommendations for the optimum utilization of computerized training systems through the conduct of an intensive analysis and evaluation of the Army's empirical data base related to computer-based training.

III BACKGROUND

A. THE PROBLEM

The introduction of computers in U.S. Army training was based on their high promise to provide more cost-effective training without detriment to the quality of training. As the result of a strong impetus from the Secretary of Defense (1965) for educational innovation including increased research and development and new methods and techniques the U.S. Army has been engaged in the development and testing of computer-based methods of instruction. Due to the high potential cost expenditure incident to computerized training systems and their impact on the traditional "modus operandi" in Army training methodology, it was decided from the outset that this teaching-learning innovation would be subjected to a rigorous evaluation of its feasibility, viability, and effectiveness prior to any extensive implementation. Subsequent to an initial feasibility study (IBM, 1968), a series of phased and special evaluations was conducted (Longo, 1969, 1972a, 1972b, 1975) to assess the merits of this new mode of instruction in teaching

Army Basic Electronics Fundamentals and related subject matter. These studies have yielded a plethora of data concerning student achievement, attrition, attitudes and other performance criteria via both computerized and conventional Army classroom instruction. Much of this valuable data, based upon a test and evaluation of two different computer-based instructional systems, has gone unreported. Due to the constraints of time and other administrative exigencies, a complete analysis and synthesis of all empirically obtained data for its operational implications, not just go - no-go decision-making pertaining to computer-based instruction (CBI), has not been possible. Through such an analysis and synthesis, this project will provide a set of empirically based guidelines for the optimum use of computer-based instruction, and recommendations for further research required in this area.

B. REVIEW OF THE LITERATURE

The introduction of the computer into the educational process per se was a natural coupling based upon the unlimited needs at all levels of education for information transmission and management on the one hand and the almost unlimited potential of the modern digital computer for information processing on the other hand. Historically, the role of computers in education was the result of evolutionary technological developments within the fields of both computers and education. Within the domain of education this evolutionary process included major developments in systems engineering, individualized instruction and teaching machines; and, within the field of computers, it included major breakthroughs in interactive terminal systems (hardware) and improved author programming languages (software). Although a full historical etiology of events in both education and computers is beyond the purposes and scope of this project, an overview of the evolution of computers in education at large, and within the U.S. Army specifically, is presented below. The use of computers in the teaching process is a matter of intense interest and concern not only to educators in general, but the U.S. Army particularly, as well. Therefore, the general context and influences within which education and computers evolved to yield computer-based education (CBE) are outlined in section B-1, and the specific factors contributing to the development of computer-based instruction (CBI) in the U.S. Army are delineated in section B-2 below.

1. General

a. Predisposing Educational Developments

(1) Systems Engineering. The influence which systems engineering exerted upon modern education has been significant and far-reaching. Ultimately, as will be discussed later, the current trend toward computers in education can be traced to the pervasive influence of systems engineering. As with other similar innovations, the roots of systems engineering run deep. Herrscher (1973) indicates that: "Although the systems approach to instruction is a comparatively new concept to many educators, it does not represent new thinking. Ralph Tyler conceptualized such an approach to instruction as early as 1935 (p. 16)." It continues to be a pervasive influence throughout modern educational and instructional innovations.

The systems approach to instruction is not a teaching method per se but a meta-method within which a variety of instructional modes can be incorporated, particularly those which are characteristically individualized and self-paced, such as computer-based instruction. Attesting to this fact, selected examples of instructional systems employed by the military, industry and academia, respectively, are illustrated below. These provide an adequate cross-sectional view of educational systems engineering in action. The U. S. Army Signal Center and School (currently the U. S. Army Communication Electronics School), Fort Monmouth, New Jersey, (Evaluation Division, 1970); the Education and Training Company (Silvern, 1972); and, the New York Institute of Technology (Schure, 1965, 1971) are representative selections.

The Army's systems approach is based on an official regulation (TRADOC, 1972), pertaining to Systems Engineering of Training, requires that all courses be systems engineered. The systems concepts adopted for course design include: (a) job analysis; (b) task inventory; (c) training objectives; (d) plan of instruction; (e) performance testing; and, (f) feedback. The main thrust is measurement and feedback to insure that course content is tied to job relevant tasks.

Silvern (1972) clearly describes his systems approach as: "... a process consisting of four major parts: (a) analysis; (b) synthesis;(c) modeling; and, (d) simulation (p. 9)." These steps are termed anasynthesis which is a metamodel generalizable to all systems.

Schure (1965, 1971) provided both a conceptualized and a pragmatic systems approach for the development, implementation and evaluation of instruction. Based upon the fundamental principles of systems engineering, Schure (1965) describes the development of a model system for the education of engineering technicians. This provided the basis for the development of Project ULTRA (Unlimited Training for All), "... which incorporates an analysis of the numerous facets and problems of education and provides an integrated solution which is orderly, accepts special cues, and matches the needs of the individuals to the requirements of society (p. 371)." In order to achieve this systems goal, it was emphasized that each individual must progress at his own rate of learning. One pragmatic extension of this model system is represented by the Automated Instructional Management System (AIMS) as described by Schure (1971). Succinctly, in classic systems fashion: "AIMS consisted of carefully specifying three sets of conditions: (a) Desired outcomes or objectives of the system; (b) A detailed audit of the characteristics of the system, the system inputs ...; (c) An explicit description of relevant means-ends relationships and methods for assessing efficiency and/or efficacy... (p. 31)."

The above works are representative of a very successful transference of systems engineering to current instructional methodology. This movement provided a fertile foundation wherein individualized instruction and teaching machines, to be discussed next, found abundant nurture. Regarding the broader relevance of the systems approach to computer-based education, Silvern (1967) argues convincingly that: " The invention of the instructional system as a subset of systems engineering, coupled with the invention of the learner-centered conceptualization, may turn out to form a combination of events which makes CAI, computer assisted instruction, a reality and not merely a learning research curiosity.... and the concept of system constitute the true foundation for CAI of the present.... and of the future (p. 82)."

(2) Individualized Instruction. Within the field of education the concept of individualized instruction has perennially projected a mystique having high intuitive value. A tutor for every student has been an elusive ideal throughout the entire history of education. The concept of individual tutors dates back to the era of Confuscius, Aristotle, Plato, and Socrates who recognized the fact of individual variabilities. Blake and McPherson (1973) trace the history of individualized instruction through the middle ages and into modern times, referencing the humanistic individualism of Rousseau; the revolutionary psychometric advances in measuring individual differences by Binet; and the idiosyncratic approach in relating to each child by Montessori. Traditionally, of course, America has made a hallmark of individuality and independence. For reasons of sheer expediency, however, it evolved that grouped instruction (teaching to the class mean) was more efficient in administering and coping with mass education. Recently, due to advances in instructional methods and strategies, the tide has turned toward catering to individual educational needs. Instructional innovations now make it feasible for students to learn on their own in a self-paced mode. The teacher has not been eliminated but rather his role

is being converted to being a tutor or guide.

In recent years, a wave of individualized instructional methods has flooded the educational community and continues to do so. These methods are highly compatible and readily complement and extend the concepts of the systems approach to education, and serve to make existing educational practice conducive to applications of computer-based education. Cooley and Glazer (1969) define individualized education as the adaptation of instructional practices to individual requirements. The link or mechanism by which this adaptation is most efficiently effected is systems engineering of instructional material: i.e., defining terminal performance objectives; identifying individual learner capabilities and needs; selecting suitable educational strategy alternatives per individual; revising system based on information feedback; and so forth. Most noteworthy, relative to computer-based instruction, is that individualized instruction lends itself to various degrees of automation, including total computerization of instruction.

Again, providing a cross-sectional view of individualized instruction in action, selected examples of its use by the military, industry and academia are cited below. The three representative examples respectively relate to: the U.S. Personnel Research Activity, San Diego, California (Harding and Fleishman, 1967); American Institutes for Research and the Westinghouse Learning Corporation, jointly (Flannagan, 1971); and, Nova High School, an educational research and development center for the Broward County Board of Public Instruction, Broward County, Florida (Arena, 1970).

The Naval Air Technical Training Command, since the early sixties, has sponsored a judicious use of individualized instruction in the form of programmed instruction (PI). Typically, its approach has been to employ PI specifically where it most appears advisable to use it and not necessarily program the entire course of instruction. Harding and Fleishman (1967) provide supportive findings for PI and indicate that group attitude toward it to be favorable. This form of individualized instruction was a logical step in the evolution of instructional methodology and has gained wide acceptance by the military services.

On a more elaborate scale, Project PLAN (Program for Learning in Accordance with Needs) represents a systems effort by the American Institutes for Research and the Westinghouse Corporation to design and implement a complete individualized instruction program. Based on the results of Project TALENT, a survey of nearly a half million students, Project PLAN emphasized the need to assist the individual to adjust to the world in which he lives. Flanagan (1971) indicated that, based on several years of implementation, PLAN does make possible individualized instruction to students on a large scale.

In an attempt to provide an effective instrument for effecting individualized instruction, eight educators, funded by the U. S. Office of Education under a Title III grant, worked on the Interrelated Mathematics Science (IMS) Project, based at the Nova High School, Broward County, Florida. Arena (1970) and Cardarelli (1972) both concur that a viable vehicle for making individualized instruction a reality is the learning Activity Package

(LAP). The LAP was conceived and developed at Nova high school. Its function is to guide the student through a highly structured program of learning materials. The Nova High School IMS Project was highly successful and points the direction for greater use of individualized instruction on both a limited and large scale.

In summary, along with systems engineering, individualized instruction represents another major evolutionary development within the domain of education which provides impetus toward full automation of instruction. As will be discussed later, both of these educational innovations precipitated the onset of computer-based instruction. However, as noted earlier, a third link in the evolutionary chain also contributed much to the generation of computer-based instruction. This was the teaching machine "boom" which is discussed next.

(3) Teaching Machines. A third major educational development giving great impetus to computer-based instruction was the "boom" in teaching machines. The vision of automating instruction achieved its first major breakthrough in the mid twenties with the work of Pressy (1926) at Ohio State University. He considered the education for the day to be destitute of any labor saving mechanism. In order to remedy this situation, Pressy (1926) invented and built a teaching apparatus which could provide drill and practice, score tests, and efficiently teach. Thus, this device could be programmed to be used both for testing and teaching. It was projected that the device could save many administrative hours used for drill and practice and scoring tests. Despite Pressy's creative ingenuity, the

teaching machine concept did not gain widespread use until Skinner (1958) combined the principles of operant conditioning and a crusading personality to make teaching machines acceptable to the educational community. The Skinnerian teaching machine was uniquely different from prior machines. It provided immediate confirmation (reinforcement) of correct responses; insured that learning was achieved with elimination of errors; and favored teaching via small incremental steps based on a linear arrangement of content material. In essence, learning was accomplished by shaping of behavior via short S-R conditioning frames, also called learning by approximations. Skinner (quoted by Eysenck, 1966) concludes that "..machines ... could be programmed to teach, in whole or in part, all the subjects taught in elementary and high school and many taught in college (p. 10)."

Skinner's approach also has not been universally accepted. It is apparent that teaching machines represent the joint effect of machine technology plus the instructional methodology incorporated within it. Ironically, just as Skinner raised questions about Pressy's hardware, so did others raise questions about Skinner's learning theory. Thus, in contrast with Skinner's small step linear method, Crowder preferred a large step branching process whereby students could be advised and receive remediation as necessary. Skinner emphasized S-R conditioning; Crowder stressed interactive responsiveness.

The sixties saw an influx of teaching machines utilizing both adroit linear programming as well as scrambled branching. Gadgetry was rampant throughout all levels of education. However, inventions to solve one set of problems have an "uncanny" way of fathering others. While most attention was focused upon hardware, little consideration was given to standardization of materials, program compatibility and machine interchangeability, as noted by Fry (1963). The teaching machine "boom" verged on bursting. The inertia toward automated instruction, however, was not to be extinguished. As predisposing influences, systems engineering, individualized instruction and teaching machines ushered the computer into modern education. The stage was set and the timing was proper for the onset of computer-based instruction. Hall (1971) emphasizes that the computer has been hailed as the most obvious next step in solving the limitations of individualized adaptation of the programmed text and teaching machine.

b. Predisposing Computer Developments

Besides a favorable educational milieu, certain developments within the computer field itself hastened the arrival of computer-based instruction, particularly computer-assisted instruction (CAI), consisting of interactive-terminal oriented instruction. In order that a CAI system could become a practical reality, three efficient hardware/software subsystems were required: a powerful central-auxiliary processor system having adequate computational, manipulative, storage and retrieval capabilities; an effective authoring language facilitating the development and debugging of instructional materials; and, a practical cost-effective interactive terminal permitting human learner interface with the computer system. The three required subsystems relate to the three major users of a CBI system:

the systems programmer, the instructional programmer, and the student. Fortunately, business and scientific demands provided the incentive for computer manufacturers to develop sufficiently powerful general purpose "maxi" computers having auxiliary features amenable, with little modification, for initial applications of CAI. Currently, however, powerful dedicated minicomputers are also available for specific purpose use. Both types of computers appear sufficient for most CBI demands in the foreseeable future. Therefore, breakthrough developments in the latter two subsystems, authoring language and student terminal, were necessary for CAI to become a reality.

(1) Authoring Language. One of the most crucial components of a CAI system, and certainly the most volatile in the state of the art, is that of authoring language. Frye (1968) classified computer languages into four categories: (a) conventional compilers (FORTRAN/COBOL); (b) adapted compilers (FOIL/CATO); (c) interactive computing and display (APL/BASIC); and, (d) special instructional authoring languages (COURSEWRITER/TUTOR/PLANIT). Respectively, the above are presented in a decreasing order of user difficulty and an increasing potential for CAI application. Hansen (1966) indicates three essential aspects of a CAI language which continue to hound language developers: power, generality and reliability. Regarding these, power pertains to conceptual and economic efficiency (i.e., communicating most with the least CPU coding per unit time); generality pertains to the applicability of the language to a wide range of instructional tasks; and , reliability refers to the internal consistency of the language to detect

logical and notational errors. The second evaluative area of ultimate importance to language design is its human factors appeal and acceptability by potential users. Unless it can be readily learned and used it will suffer extinction. Some success in authoring ease has been achieved with the development of the following CAI languages: COURSEWRITER, DIALOG, CAL, INFORM, LYRIC, TUTOR AND PLANIT (CONARC, 1972).

Once the authoring language problem was attacked for solutions, the number of CAI languages proliferated. While each served the special purposes for which designed and intended, again the attempted solution bred another problem. The new problem concerned compatibility among languages and machines. This impinges directly upon the transportability of instructional materials which is of great importance particularly within and among the tri-services. Zinn (1972) notes over 40 instructional languages had been developed. Many more have been born since then. The problem of compatibility among languages and machines is an increasing one. The solution to the problem is the development of a machine independent language or meta-language. Aaronson (1971) of the Systems Development Corporation, the PLANIT developers, considers PLANIT to be a meta-language, or at least a meta-FORTRAN. Full development of an acceptable meta-authoring language would be historic for CAI. Such a breakthrough would bridge CAI from its status of token implementation to full fledged application, having the "carrot" of portability as its attraction. Solution to this problem will mark the advent of widespread use of this mode of computer-based instruction.

(2) Interactive Terminal. A second crucial computer subsystem development engeneering the advent of computer-based instruction consisted of advances in interactive terminals, principally the alpha-numeric character and graphic display types. Molnar (1972) describes the basic input-output terminal associated with CAI: the cathode-ray tube (CRT) which consists of an alpha-numeric typewriter keyboard and a CRT display for text and graphic materials provided according to the logic of an instructional model and programmed strategies. A highly successful application of the CRT for CAI, but extremely limited regarding mass student usage, was the IBM 1510 display console consisting of a light pen, keyboard and CRT used with the IBM 1500 Instructional System. Besides the light pen, which is pointed at the CRT for making responses, the "joystick" and "mouse" are also available. These are moved manually by the student which in turn cause a spot on the CRT to move. Another variation of the interactive terminal is the RAND tablet which is a device pressure sensitive to the position of a pencil-like stylus used to write or draw on a tablet which is automatically inputted to the computer and displayed.

Walker (1970) indicated that the: "Teletype terminal is undoubtedly the most commonly used terminal device in the country. Constituting the basic terminal in the CAI systems sold by RCA and Hewlett-Packard and some systems sold by IBM, the teletype terminal is probably the least expensive device currently available for sale (p. 8)." However, although it is highly cost effective and has other favorable qualities, it likewise has several displeasing qualities particularly its high noise level and slowness.

Primarily for reason of cost, widespread use of the RCA ASR-33 teletype terminal has been made by CAI users rather than the CRT type display terminals. It appears that increased demand with mass production will resolve this problem.

Obviously, the trend toward multi-media, popular in modern education, also has been incorporated in computer-based education with as many of the media devices interfaced with the computer as the state of the art will permit. Full automation of the learning center under computer control has been an elusive goal for many educators, however it can be approximated quite closely with many devices capable of being interfaced with the computer. Such devices, besides those described above, include: auxiliary image projectors, audio devices, touch panels and the plasma display panel. The latter device, developed at the University of Illinois (Bitzer, 1970, 1971) represents unique capabilities relative to the CRT. Unlike the CRT, it requires no image regeneration. In summary, while a truly cost-effective student terminal with wide appeal is within sight, the CRT, Plasma and teletype terminals have been advanced to make true interactive CAI a reality.

2. Specific

a. U.S. Army Multi-Level Effort

(1) Department of Defense Impetus. The introduction of computers in U.S. Army training was based on their high promise to provide more cost-effective training without detriment to the quality of training. The Army has been involved in the development of a computer-based instruction (CBI)

capability since 1965 when the Secretary of Defense promulgated a letter to the Service Secretaries concerning innovations in Defense Training and education (DOD, 1965). The Office of the Chief of Research and Development (OCRD) and the Continental Army Command (CONARC) produced separate technical development plans (TDP). These were staffed at the DOD level. A single TDP was approved early 1967 for the development of a prototype CAI system and the conduct of a feasibility study using available IBM equipment. These two requirements were delegated to the Human Resources Research Organization (HumRRO), Alexandria, Virginia, under the auspices of Project Impact, and the U. S. Army Signal Center and School (USASCS) then located at Fort Monmouth, New Jersey. A brief description of these two efforts is outlined below.

(2) HumRRO Effort. HumRRO, at the time a Federal Contract Research Center for the Army and operating under the auspices of Project Impact, sponsored an advanced development effort designed to provide the Army with an effective and economical CAI system. The goal was to develop two generations of prototype individualized CAI systems. This effort was phased into four cycles to include four interrelated areas: hardware, software, instructional materials, and an instructional decision model.

The original Project Impact was planned to be completed by the end of FY-71. This time frame was extended because of changes in the project scope and funding limitations. The architecture of HumRRO's CAI system evolved to include the IBM 360 series computer, a Sanders-720 student terminal, and a modified COURSEWRITER III language. Further, HumRRO developed a COLBOL CAI course of instruction and an instructional decision model (IDM) and conducted other research tangential to effecting a full operational CAI system. It occurred, however, that upon completion of cycles 1 and 2, a decision was made to transfer responsibility for the development of a fully automated CBI system to the Product Manager, Computerized Training System (CTS), Fort Monmouth, New Jersey in August, 1972.

(3) CONARC Master Plan. In accordance with a master plan (CONARC, 1968), the Army sponsored a number of delimited applications of CBI within the CONARC schools. However, the foremost application was represented by the CAI Project at the U.S. Army Signal Center and School (USASCS), Fort Monmouth, New Jersey. The Project was initiated in August 1966 with the submission of a CONARC TDP entitled "Computer Assisted Instruction in Electronics Training." Subsequently, a CAI Feasibility Study was required (CONARC, 1967) to determine the appropriateness of CAI to Army training. The feasibility study was conducted under contract with the IBM Corporation between June - December, 1967 using the IBM 1500 Instructional System installed at the U.S. Naval Academy, Annapolis, Maryland. The favorable results of the feasibility study permitted continuation of the CAI Project and the letting of another service contract leading to the installation of an IBM 1500 CAI System at USASCS.

(4) USASCS CAI Project. The USASCS approach to CAI consisted of individualized self-paced course material formatted predominantly in the tutorial mode. The subject matter consisted of Army Common

Subjects Basic Electronics taught at USASCS. Since the Project was a user-development effort, focus was placed on expedient development and operational use of the CAI lesson material in the Basic Electronics Program.

During the period of June 1968 through December 1971 the equivalent of four weeks of instruction in basic electronics was developed and implemented for CAI presentation and approximately 1300 students participated in this course of instruction. As the result of this user-development effort, the USASCS CAI Project developed a staff of military and civil service personnel who are fully capable of performing all tasks associated with directing and operating a CAI system. Contractor support for system maintenance, or course, remains the most effective and economical alternative to minimize system down-time.

Other significant by-products of the CAI four year project included the development of: an instructional model (Mizenko, 1971); a one-man authoring concept of lesson development; a macro system which eliminated the need for lengthy and repetitive computer coding (USASCS, 1970); three student performance analysis programs; an automatic student registration procedure (Evans, 1971); a subroutine system to permit maximum lesson material to be disk resident while the instructional strategy was core resident thus extending the amount of lesson material capable of being on-line; a suggested modification of CORSEWRITER II Interpreter (USASCS, 1971); a CAI Instructional Programmer Training course; and, an instructional programming guide for CAI course material (Kimberlin, 1971).

b. USASCS CBI Evaluation Effort

Due to the high potential cost expenditure incurred by computerized training systems and the relative infancy of this innovative technology, it was decided at the outset that the Army's CAI Project would undergo a rigorous formal evaluation of its feasibility, viability and effectiveness prior to any extensive implementation. Subsequent to the CAI Feasibility Study (IBM and CONARC, 1968) a series of phased and special evaluations was conducted in conjunction with the four year CAI user-development effort with the IBM 1500 Instructional System (Longo, 1969, 1972a, 1972b) and a three year applied research effort with the PLATO IV plasma display terminal (Longo, 1975). The purpose of these evaluations was to assess the merits of this innovative training system in teaching Army Basic Electronics Fundamentals and related topics via both CAI and CMI applications of computer-based instruction. The results of these studies provided the evidential basis for administrative decision-making regarding the overall acceptability and direction of CBI within the U. S. Army. A plethora of data was obtained concerning student attrition, achievement, attitudes and other performance criteria via both computerized and conventional Army classroom instructor training. However, except for CBI go - no-go inferences, much of this valuable data, based upon a multi-phase test and evaluation of two different CBI systems, has gone unreported; due to constraints of time and other administrative exigencies, a complete analysis and synthesis of all empirically obtained data for its operational implications has not been possible. Through such an analysis and synthesis, this project will provide empirically based guidelines regarding the optimum application of CBI as it pertains to a number of parameters relating to course and student effectiveness; and, empirically based recommendations regarding further research required for the thorough enhancement and application of this new instructional technology in the U. S. Army.

IV MAJOR ISSUES AND RESEARCH QUESTIONS

In order to attain the purpose of this project as stated in section II and in accordance with the nature of the problem as stated in section III-A, the following major issues, their associated research questions and assessment criteria will be addressed.

A. ISSUE A: Replication of Effectiveness: CBI vs CI

Semantically, effectiveness is open to myriad definitions; and, experimentally, it is open to equally as many approaches regarding its assessment. Therefore, it is appropriate to further specify: the context within which effectiveness of CBI is being viewed; the research questions being addressed and the performance and affective criteria to be used, as appropriate, for assessment purposes.

1. Context

The primary overriding concern of any instructional innovation centers upon its reliable (replicated) effectiveness relative to already available instructional methods, i. e., conventional instruction (CI). In other words, why change vehicles? Further, initial concern for effectiveness is usually directed toward its feasibility and, subsequently, it is relegated to an analysis of its validity as it pertains to assessment of substantially larger samplings of course content, students and time. The latter, besides contributing to the development of guidelines for CBI use, will also yield an important by-product measure of the Hawthorne Effect, a fundamental aspect of short versus long term data reliability.

2. Research Questions

Within the above stated context, therefore, Issue A can be translated into the following four research questions:

a. What is the degree to which the U. S. Army has demonstrated the effectiveness of CBI in teaching Basic Electronics Fundamentals, from the point of view of its feasibility and viability?

b. What is the degree to which the initial CBI feasibility results were replicated across three interim studies and a final summative evaluation, each employing increased sampling of both students and instructional material?

c. What inferences relevant to optimizing CBI operationally are available from the CBI vs CI comparative analyses?

d. What does the CBI vs CI comparative analyses suggest for further required research regarding CBI?

3. Performance Criteria

Regarding the information needed to address the four above research questions, the following performance criteria of effectiveness will be utilized in the assessment process:

a. Achievement. Verbal tests, developed and validated in-house by subject matter and testing specialists of the Test and Development cadre at the Common Subjects Fundamentals Branch of USASCS, are available as measures of student achievement. Two types of achievement are measured for official records: written (for theory materials) and performance (for practical exercises). Further description of these tests is given in section V-C-2(a).

b. Attrition. Two measures of student attrition are officially made available: academic and administrative.

c. Completion Time. This criterion has come to be the cardinal factor in defending the economic merits of CBI. "Time is money" is axiomatic in large scale training centers.

Considering the four major research questions on Issue A and the three basic performance criteria applicable to each question, this yields a set of twelve areas (potential sub-questions) to be addressed regarding: the comparative effectiveness of CBI vs CI; and, suggested guidelines and research on CBI.

B. ISSUE B: Replication of Effectiveness: $CBI_{(1)}$ vs $CBI_{(2)}$

1. Context

The second overriding concern of an instructional innovation pertains to its relative merits versus other similar systems. As emphasized in research protocol, there is no substitute for replication of findings. Therefore, after determining in what areas and to what degree CBI is more/less effective than CI, it becomes paramount to ascertain the commonalities/differences in effectiveness between two CBI systems per se. As noted earlier, the two subject CBI training systems are: (a) the IBM 1500 Instructional system: ($CBI_{(1)}$); and (b) the PLATO IV Computer-based Educational System: ($CBI_{(2)}$). Besides contributing to crystallizing guidelines for operational use of CBI, analysis of two different CBI systems will provide needed evidence on the fundamental issue whether CBI systems of various types are similarly effective. Because of the infancy in this state of the art, it should be noted that such comparisons between CBI systems are practically nonexistent. In order to establish a basis for comparison, student disposition toward each CBI system was selected to provide the reference point for analysis vis-a-vis each system.

2. Research Questions

Within the above stated context, therefore, Issue B can be translated to ask:

a. How do two different computer training systems: the IBM 1500 Instructional System and the PLATO IV Computer-based Educational System compare with respect to varied affective criteria?

b. What inferences relevant to optimizing CBI operationally are available from the $CBI_{(1)}$ vs $CBI_{(2)}$ comparative analysis?

c. What does the $CBI_{(1)}$ vs $CBI_{(2)}$ comparative analysis suggest for further required research regarding CBI?

3. Affective Criteria

Regarding the information needed to address the above research questions, the following affective criteria of effectiveness will be utilized in the assessment process:

a. Student Attitudes. Specially designed attitude questionnaires, developed in-house by the evaluator, are used to measure student attitudes.

b. Student Opinions. Included in the attitude questionnaires were ample opportunities for expressed opinions by students.

c. Student Suggestions. Included in the attitude questionnaires were ample opportunities for expressed suggestions by students.

Further description of these questionnaires is given in section VI-C-2(b).

The design and administration of these attitude questionnaires is discussed in the following section. Considering the three major research questions raised by Issue B and the three affective criteria of effectiveness applicable to it, this yields a set of three areas (potential sub-questions) to be addressed regarding affective student disposition toward the two separate computerized training systems $CBI_{(1)}$ vs $CBI_{(2)}$; and, suggested guidelines and research on CBI.

C. ISSUE C: Factors/Relationships Unique to CBI

1. Context

The third overriding concern of an instructional innovation pertains to the factors and relationships which are unique to it. Knowledge of relevant variables and their relationships is the necessary first step toward their facilitative use and manipulation directed toward their ultimate control. Due to the infancy of CBI, insight into those factors associated with it is as yet in the exploratory stage. Therefore, it is posited here as the third important area for investigation. Through a correlational analysis of all obtained measures, including study of the predictor - predictor and predictor - criterion relationships, a significant step toward deriving a set of guidelines for use in CBI is anticipated.

2. Research Questions

Within the above stated context, therefore, Issue C can be translated to ask the following:

a. What are the relationships inherent in both the pre- and on-going CBI training variables, considering all available predictor and selected criterion measures, as related to the following perspectives:

(1) Parametric description of CBI variables?

(2) Understanding of CBI influences/relationships?

(3) Prediction of student performance/success?

b. What inferences relevant to optimizing CBI operationally are available from an analysis of the factors/relationships unique to CBI?

c. What does the analysis of the factors/relationships unique to CBI suggest for further research regarding CBI?

3. Validation Criteria

Regarding the information needed to address the above research questions, besides the predictor variables which will encompass the available pre- and on-going measures, the following validation criteria of effectiveness will be incorporated in the assessment process:

a. Achievement. Represented bya set of continuous criteria. (Cf. section IV-A-3(a))

b. Attrition. Represented by a set of dichotomous criteria.(Cf. section IV-A-3(b))

c. Completio Time. (Cf. section IV-A-3(c))

d. Attitude Scores. (Cf. section VI-C-2(b))

Considering the five major research questions raised in conjunction with the four validation criteria of effectiveness, and allowing for a certain degree of overlap among the possible combination of information cells (i.e., questions x criteria), approximately twelve areas (potential sub-questions) will be addressed regarding the analysis of factors/relationships unique to CBI; and, suggested guidelines and research on CBI.

V LIMITATIONS OF THE STUDY

It should be noted that inferences drawn from the findings relating to the above issues and research questions must be interpreted basically in terms of two operational training systems rather than a rigidly controlled laboratory experiment. Of course, it is recognized that many researchers have recently argued just as strongly in favor of realistic operational evaluation designs as others have advocated rigidly controlled research paradigms conducted in a "sterile" laboratory. There are trade-offs for both approaches. Thus, the study procedures for this project may be generally characterized as quasi-experimental.

Secondly, it should be emphasized that the study findings are generalizable primarily with respect to the tutorial mode of CAI which was employed in the instructional logic of the CAI material used. Some CAI drill and practice was included, however only to a small degree. Therefore, strictly speaking other modes of computer-based instruction (e.g., drill and practice, dialogue, problem solving, simulation etc.) should be investigated separately for their own respective merits.

Thirdly, in keeping with the nature of student and subject matter sampling, the results are generalizable only to similar student populations and equivalent courses. Also, relatively speaking, the IBM 1500 study analysis represents both a larger sampling of students and subject matter in comparison with the PLATO IV study sampling.

VI PROCEDURES AND METHODOLOGY

A. GENERAL RESEARCH METHODOLOGY

In view of the fact that this project has a number of major issues and research questions, it engages more than one method of research. Naturally, the selected research methodology is issue/question dependent. Based on the respective issues and questions involved, the following research methods will be employed.

1. Issues A/B

Since these issues will employ control and experimental groups, as obtained in an operational setting, and include statistical tests of significance between them, the general research methodology to be used in this project will be considered as quasi-experimental.

2. Issue C

Similarly, since relationships will be ascertained between several sets of independent variables and severaldependent variables, the appropriate method to be employed will be correlational analysis to study the relationships among the variables. More specific details regarding the research methodology to be employed are contained in sections B - D below.

B. INFORMATION SOURCES

The data analysis for this project, as described in section D below, will be based on the data "bank" of information derived for an initial feasibility study and a series of six related CBI studies conducted in-house by this writer. As per each of the major issues this includes:

1. Issue A

Analysis will be based on data files derived for an initial CBI feasibility study, four interim investigations, and a final summative evaluation of CBI.

2. Issue B

Analysis will be partially based on data files relating to the IBM 1500 System analysis and partly as regards the PLATO IV Plasma Terminal evaluation, all obtained in-house by this writer.

3. Issue C

Analysis will be based on Pearson Product Moment correlation matrices constructed from appropriate predictor-criterion data files as appropriate.

Further descriptions of the statistical tests and analysis to be employed will be given in section D below.

C. SAMPLING, INSTRUMENTS AND VARIABLES

1. Sampling

(a) Students. The student sampling is representative of normal inputs of draftees and Regular Army students into the Army's Common Subjects Basic Electronics Course.

(b) MOS. The Military Occupational Specialties (MOS) sampling will include (1) the Strategic Microwave System Repair (26V20); and, (2) the Fixed Station Technical Controller (32D20). These two MOS's were selected because of their representativeness of qualifications required for basic electronics training, optimum size of class inputs, and frequency of reporting dates.

(c) Subject Matter. The instructional material sampling for the most part encompasses the subject matter taught in the first four weeks of Army Common Subjects Basic Electronics. This is equivalent to 102 hours of the conventional Plan of Instruction (POI). This material is subdivided into phases of instruction of two weeks per phase. Assessment will include phase level comparisons. Related subject matter is employed in both the IBM 1500 System and the PLATO IV System analysis.

2. Instruments

(a) Achievement Tests. Both written and performance measures, officially obtained at the end of each phase of instruction are used. Where control and experimental (i. e., CI vs CBI) comparisons are to be made, such will be based on administration of the same achievement tests to both' groups. The following phase achievement tests are employed in the IBM 1500 System analysis (Issue A):

(1) Written:

i) Phase I: (Wks. 1-2: Cf. Appendix A)

ii) Phase II: (Wks. 3-4: Cf. Appendix B)

(2) · Performance:

i) Phase I: (Ibidem: Cf. Appendix C)

ii) Phase II: (Ididem: Cf. Appendix D)

Testing of the PLATO IV System for this project consisted of attitude measurement as represented by a 28 item questionnaire. (Cf. (b) next.)

(b) Attitude Questionnaires. Attitude testing on the IBM 1500 System consists of a short questionnaire used to obtain student attitudes, opinions and suggestions toward CBI. Basically, the questionnaire consists of 22 Likert items designed to yield both item and overall attitude scores. The questionnaire is constructed in two parts: (1) comparison of CBI with CI (11 items); and, (2) assessment of CBI per se (11 items). An ordinal scale of 1-5 for each item yields total score variations ranging from: Pro-CBI - Neutral - Pro-CI for Part I; and, "Favorable" - Neutral - "Unfavorable" for Part II. (Cf. Appendix E).

Attitude testing on the PLATO IV System consists of a 28 item questionnaire subdivided into two parts: (1) three different CBI modes of instruction (14 items); (2) the PLATO IV terminal per se (14 items). (Cf. Appendix F).

3. Variables

The relevant independent and dependent variables pertaining to this project are represented as follows:

(a) CBI vs CI Achievement Assessment. Variables included herein basically consist of two independent and four dependent measures. The independent variables are: training method (varied 2 ways: CBI/CI), and aptitude level (varied 3 ways: hi/mid/lo); the dependent variables are: achievement (written/performance), time to complete instruction, attrition rate, and attitude toward CBI.

(b) $CBI_{(1)}$ vs $CBI_{(2)}$ Affective Assessment. Variables herein, as addressed by this project, basically consist of one independent variable: training method (varied 2 ways: $CBI_{(1)}/CBI_{(2)}$; and one dependent variable: student attitude (varied 2 ways: item/total score).

(c) Achievement/Affective Correlational Assessment. Variables included herein, basically consist of all predictor-criterion measures available under both the CBI and CI modes of instruction. In accordance with standard correlational matrix format, the predictor variables will represent the independent variables and the criteria will represent the dependent variables.

D. STATISTICAL ANALYSIS, DATA PRESENTATION, INTERPRETATION

Statistical analysis, data presentation and interpretation will be conducted as follows:

1. Issue A

The basic design and findings of each CBI vs CI study will first be delineated. The analysis of these studies will include an array of descriptive and inferential statistics as the respective independent-dependent variables dictate. This will include simple descriptive measures (M, S.D., %); the "t"test for both correlated/uncorrelated samples; the F test: analysis of variance (ANOVA) two way fixed effects; and, X^2 test of correlated proportions as the logic of the measures and situation dictates. The data will be presented via standard tabular format. As appropriate, the p levels of .05 and below, for both parametric and nonparametric tests of significance, will be indicated. Where the study variables permit, interpretation vis-a-vis major Issue A (and its associated research questions) will include an assessment of the effectiveness of CBI in teaching Basic Electronics Fundamentals. Also, the degree of replication across the feasibility, interim, and final summative evaluation will be assessed by means of the "t" test for independent means and the F-max test for variances. Lastly, a detailed interpretation of these findings on student achievement will be made for their contribution toward shaping guidelines for optimum utilization of CBI.

2. Issue B

The basic design and findings of the $CBI_{(1)}$ vs $CBI_{(2)}$ study (i.e., IBM 1500 System vs PLATO IV System) will first be delineated. Analysis will include, where feasible, the X^2 test of proportions. Further, student opinions and suggestions will be subjected to content analysis. The data, both quantitative and qualitative, will be presented via both standard tabular and figural formats as appropriate. Interpretation, vis-a-vis major Issue B (and its associated research questions) will include both inter and intra-assessment of the two CBI systems with respect to: student attitudes, opinions, and suggestions. Lastly, specific interpretation of these affective findings on student attitudes will be made for their contribution toward shaping guidelines for optimum utilization of CBI.

3. Issue C

A correlational analysis will be conducted on all obtained measures having sufficient sampling. This will include a study of predictor-predictor as well as predictor-criterion relationships. Analysis will include intercorrelations; the Wherry-Doolittle matrix solution, a multiple linear regression technique yielding multiple R^2 and the repertoire of simple and multiple regression statistics: i.e., B (beta) weights (standard score form); "b" weights (raw score form); etc. The data will be presented in standard tabular format indicating all basic correlation matrix data including means, standard deviations and correlation coefficients. Interpretation will include: description of select CBI parameters; analysis of relationships peculiar to CBI; and, a determination of how predicted scores may be employed in CBI for instructional modeling and administrative student go-/no-go decision-making purposes. The scope of this analysis will extend to both the CBI achievement and attitudinal measures. As indicated for Issues A and B, this analysis also will be directed toward shaping guidelines and recommendations for optimum utilization of CBI.

VII RESULTS AND ANALYSES

The results and analyses of each of the three major issues and their subsidiary questions are presented in this section. A synthesis of the findings in the form of guidelines for action and recommendations for future research are presented in the following chapter.

A. ISSUE A: Replication of Effectiveness: CBI vs CI

This issue primarily addressed the verification of initial CBI feasibility study results across several interim evaluations culminating in a final summative evaluation. Each of the follow-up studies involved a comparison of CBI with conventional classroom instruction (CI) and increasing amounts of electronics course material. Intrinsic to this multi-study replication was a demonstration of the effectiveness of CBI to teach Army basic electronics. Inferences relevant to optimizing CBI operationally and recommendations for future research, the essential products of this project, are discussed in the following chapter. The evaluation studies addressed in the analysis of Issue A include: the feasibility study, a follow-up to the feasibility study, three interim evaluations and a final summative evaluation. It should be noted that the basic analysis of this particular issue is necessarily limited to the historical data sources and records available, thus rendering their design methodology quasi-experimental. Also, as noted in the "Limitations of the Study" section (chapter V), it should be emphasized that "...the findings relating to the above issues and research questions must be interpreted basically in terms of two operational training systems rather than a rigidly controlled laboratory experiment." The scenario for the below analyses will consist of an exposition of the basic design and findings of each CBI vs CI evaluation, to include a brief resume of each evaluation study reported.

1. CAI Feasibility Study (Wk. 1: 11 1/4 Hrs.)

a. Basic Approach/Results

The initial CAI feasibility study (CONARC and IBM, 1968) was based on the first week of basic electronics material (11 1/4 hrs.) taught by the Common Subjects Branch of the Department of Specialist Training, USASCS, Fort Monmouth, New Jersey. The basic design and results are contained in Tables 1-4.

Table 1

Experimental Design for Feasibility Study

Aptitude Levels	Instructional Methods		
	CAI	TV	IC
High	6	6	6
Medium	6	6	6
Low	6	6	6
N	18	18	18

As indicated in Table 1, the feasibility consisted of three training methods (CAI/TV/IC) at three aptitude levels (Hi/Med/Lo), (N. B. IC = Instructor Controlled). With 6 replications of experiment, this yielded an n of 18 per method and a total N of 54. Both pretest and post test achievement data were obtained on all subgroups. This data was subjected to a fixed effects analysis of variance (ANOVA: based on a 3 x 3 methods by aptitude data matrix).

An ANOVA of the pretest and post test data (Tables 2, 3) indicated that all three treatment (methods) groups exhibited equivalent achievement both prior to and after their respective treatments. The nonsignificance

Table 2

Analysis of Pretest Data

Source	SS	df	MS	F
Instructional Method	194.04	2	97.02	1.19
Aptitude Level	6088.04	2	3044.02	37.49*
IM x AL	159.20	4	39.80	.49
Residual	3654.00	45	81.20	

*$p < .001$.

of the methods main effect for the pretest data (Table 2) insured an adequate sampling basis existed for further testing of the methods effect in the post test data (Table 3). The nonsignificance of the methods main effect for the post test data demonstrated that none of the mean differences after the three training methods were administered ended up statistically significant. This result held also across all three aptitude levels, as indicated by a nonsignificant interaction effect. As expected, the aptitude level differences in both situations were significant.

The standard assumptions for ANOVA were met or approximated in the above ANOVA as follows:

(1) Random Sampling. As indicated in Table 1 the n's are the

same (6) for each method x aptitude cell. The selection and allocation of students within each of the cells were random thus insuring independent observations within sets.

Table 3

Analysis of Post Test Data

Source	SS	df	MS	F
Instructional Method	180.78	2	90.39	1.27
Aptitude Level	10075.12	2	5037.56	70.86*
IM x AL	256.44	4	64.11	.90
Residual	3199.05	45	71.09	

*$p < .001$.

(2) Homogeneity of Variance. As indicated in Appendices G-H, the aptitude level variances showed marked differences in both the pretest and particularly the post test scores. Using the F max-variance test for independent variances, the following was obtained:

(a) Pretest Variances:

where: $S.D._{(1)}^2 / S.D._{(2)}^2 = 2.24$

and: $df = 18, 18$

then: $F = 2.24$ (significant: $p < .05$)

(b) Post Test Variances:

where: $S.D._{(1)}^2 / S.D._{(2)}^2 = 3.77$

and: $df = 18, 18$

then: $F = 3.77$ (significant: $p < .01$).

Given that the $\underline{F}$ test for the pretest variances was significant at the .05 level, and the post test variances significant at the .01 level, the use of a more stringent $\underline{F}$ level for the aptitude main effect was indicated, (Guilford, 1965). In such cases, an accepted practice is either to reduce the number of degrees of freedom by 1/2 or, more directly, cut the alpha level projected for use by 1/2. As is known, this effectively compensates for any artificial inflation of the mean square for the partition in question (i.e., aptitude level) and possible overstatement of significance of differences in that area. Consequently, based on an alpha level of .005 (i.e., 1/2 of .01), the resultant $\underline{F}$'s for both the pretest and post test aptitude main effect still attained significance: i.e., $\underline{p}$ in both cases was $<.001$. Therefore, the lack of aptitude level homogeneity of variance did not impact adversely on the results of either ANOVA. The use of 1/2 the alpha level (McNemar, 1949) effected a more stringent test of significance in this case than would have been achieved by reducing the $\underline{df}$ by 1/2 (Snedecor, 1946).

(3) Normality of Distribution. The initial feasibility study (Conarc and IBM, 1968) assumed the position advocated by the classic Norton studies (cited in Guilford, 1965) on the effects of nonnormality of distribution and heterogeneity of variance on ANOVA. This posits that $\underline{F}$ is rather insensitive to variations in shape of distribution but more sensitive to heterogeneity of variances and only when variances are markedly different.

Besides data on student achievement, a measure of time to complete week I CAI material was obtained also. In comparison with the fixed instruction time of 11.25 hours for the TV and IC methods, the CAI group demonstrated a mean time of 10.03, a 10.8 % reduction in training time.

Table 4

Summary of CAI/CI Module Completion Time

Aptitude Level	CAI M (Hrs)	CI M (Hrs)
High	5.72	11.25
Medium	9.37	11.25
Low	15.00	11.25
Total Group	10.03	11.25

Note. CAI strategy was self-paced.
CI strategy was lock-step.

Because of the complete lack of variability in the CI completion time, the differences between the means were not amenable to significance testing. A summary of the CAI/CI student completion time is contained in Table 4.

b. Resume of Results

The CAI feasibility study achievement results indicated that, on the average, CAI was as effective in teaching basic electronics as either the TV or IC methods. This held true across the entire aptitude range. In contrast, a modest time savings was obtained by the CAI group through self-paced instruction. The basic feasibility study conclusion therefore was that the CAI group achieved equally as well but in less time than its counterpart CI group. This finding forms the basis for the replication study analyses to follow.

2. Feasibility Study Follow-up (Wk 1: 11 1/4 Hrs.)

a. Basic Approach/Results

Subsequent to the feasibility study, a follow-up study (Longo, 1969) was conducted on a slightly revised version of week I (11 1/4 Hrs.) basic electronics course material. Based on the feedback obtained during the conduct of the feasibility study, a few lessons were consolidated for a clearer presentation. By design, this follow-up study endeavored to improve on a basic feasibility study weakness: i.e., small sampling. While the feasibility study was conducted under severe constraints of time and CAI terminal availability, the follow-up study was able to accrue a more respectable sample size. Thus, in contrast with the feasibility n's of 18 per condition, the follow-up N's were 278 per study group. The basic

Table 5

CAI vs CI: Matching Characteristics
(Wk. I: 11 1/4 Hrs.)

Matching/Aptitude Measures	r^a	CAI M	CAI SD	CI M	CI SD	t^b M	t^b SD
Pred. Ph. I[c]	1.00	103.30	11.40	103.30	11.40	---[d]	---[d]
Age	.50	20.16	2.49	20.10	1.76	.52	4.34*
Education	.49	12.78	1.45	12.90	1.45	1.38	---[d]
Electronics	.52	121.40	12.05	120.62	12.26	1.07	.33

Note. Matching/Electronics measures = standard score form. (N=278)
[a]Pearson Product-Moment correlation: between the 2 study groups.
[b]t test(for correlated means/s. d's): for 277 df, t=1.97/2.59 at .05/.01.
for 139 df, t=1.98/2.61 at .05/.01.
[c]Matching variable: matching by pairs design.
[d]No absolute difference obtained.
*$p < .01$.

results are contained in Tables 5-7. As indicated in Table 5, the two study groups were equivalent on the matching variable (predicted phase I) and were also found to be equated on three other available measures: age, education, and electronics aptitude. This equivalence pertained to both the means and variabilities of all four measures (except for age variability). Statistically, based on the t test using 1/2 the df, as recommended

Table 6

CAI vs CI: Phase I Achievement/Time
(Wk. 1: 11 1/4 Hrs.)

Matching/Performance Measures	r[a]	CAI M	CAI SD	CI M	CI SD	t[b] M	t[b] SD
Pred. Ph. I[c]	1.00	103.30	11.40	103.30	11.40	---	---
Written I[d]	.61	61.92	13.25	62.44	12.84	.75	.66
Time I	---[e]	8.99	3.02	11.25	---[e]	(20.1 % Reduction)	

Note. Matching/Achievement measures = standard/raw scores respec'ly. Time = in hours. (N=278)
[a]Pearson Product-Moment correlation: between the 2 study groups.
[b]t test (for correlated M's/SD's): for 277 df, t = 1.97/2.59 at .05/.01.
[c]Matching variable: matching by pairs design.
[d]Written I: represents only week 1 of phase I.
[e]CI group: fixed time = no variation (thus no r or SD possible.)

where variances are significantly different (Edwards, 1954; Snedecor, 1946), the age mean difference still was nonsignificant. Thus, given the two study groups were equivalent, experimental comparisons between them were possible.

Analysis of the two criterion measures, written test I and time-to-complete I is contained in Table 6. As indicated, the two groups demonstrated equivalent achievement on the written test. However, a substantial difference existed between the groups on the time-to-complete I measure. The difference, in favor of the CAI group, was 2.26 hours (11.25 - 8.99). This effected a 20.1 % reduction (savings) in training time. It should be noted that due to the lock step nature of the CI instructional package no variability (SD) in time-to-complete was obtained. This precluded proper computation of any correlation between the two study groups and, consequently, any computation of a parametric test of significance on this variable.

Table 7

Feasibility vs Follow-up CAI: Achievement/Time
(Wk. 1: 11 1/4 Hrs.)

Performance Measures	Feasibility CAI M	SD	Follow-up CAI M	SD	t[a] M	F[b] SD
	(N=18)		(N=278)			
Written I[c]	60.20	14.40	61.92	13.25	.49	1.18
Time I	10.03	3.83	8.99	3.02	1.13	1.61

Note. Written Test = raw score form only.
[a] t test (for independent means): for 294 df, t = 1.97/2.59 at .05/.01.
[b] F test (for independent SD's): for 277, 17 df, F=1.95/2.61 at .05/.01.
[c] Written I: represents only week 1 of phase I; 85 items - raw score form.

The basic comparative results between the feasibility study and its follow-up analysis are contained in Table 7. As indicated by the t test for independent means and the F test for independent variances, no significant difference in means and variances was obtained between the two CAI studies (feasibility/follow-up) on the two performance measures employed. Thus, on the basis of their mean written scores, the two study groups differed by only 1.72 (i.e., 61.92 - 60.20); and, regarding their mean time scores, a difference of only 1.04 (i.e., 10.03 - 8.99) was obtained. Similarly, negligible differences were obtained on the variances of these two variables between the two study samples. The lack of significant differences in both means and standard deviations represents replication of the feasibility study results.

b. Resume of Results

As with the feasibility study, the follow-up achievement and time results supported the effectiveness of CAI. Basically, it was observed that, relative to CI performance, the follow-up results supported the feasibility findings that CAI effects equal or better achievement than CI, and in substantially less time.

3. CAI Interim Study (Wks. 1-2: 42 Hrs.)

Subsequent to the follow-up study, two interim studies and a final summative evaluation (Longo, 1971a, 1971b, 1972) were conducted on the feasibility and viability of applying CAI in teaching Army basic electronics instructional material and representative performance tasks. By design, each succeeding study employed increased amounts of basic electronics instructional material and larger sampling of enlisted Army personnel relative to the initial feasibility study. Respectively, these three studies included the following content/student sampling: (a) weeks 1-2: 42 hours/$\underline{N}$=155; (b) weeks 1-3: 72 hours/$\underline{N}$=121; and, (c) weeks 1-4: 102 hours/$\underline{N}$=109. Except for weeks 1-3 analysis (cf. section 4 below) student sampling in all studies was drawn at random from the same two Army MOS's used in the CAI follow-up study: (a) 26V20: Strategic Microwave System Repair; and, (b) 32D20: Fixed Station Technical Controller System Repair. Similar to all the evaluations, the basic design for the interim studies consisted of two matched groups, one used as a control group (CI) and the other as the experimental group (CAI). It should be noted that in all studies in the series, except the final summative evaluation, the CI time-to-complete criterion represented only fixed POI (plan of instruction) time and excluded setback time. However, the summative evaluation included all setback time, thus permitting time variability in both study groups. The interim study results reported next pertain to weeks 1-2 (42 hours).

Table 8

CAI vs CI: Phase I Achievement/Time
(Wks. 1 - 2: 42 Hrs.)

Matching/Performance Measures	r^a	CAI M	CAI SD	CI M	CI SD	t^b M	t^b SD
Pred. Ph. I[c]	1.00	101.55	10.55	101.55	10.55	---	---
Written I	.48	101.05	19.41	99.65	19.15	.89	.19
Performance I	.36	107.00	16.91	103.29	18.13	2.34*	.92
Time I	---[d]	29.92	12.30	42.00	---[d]	(29% Reduction)	

Note. Matching/achievement measures = standard score form. (N=155)
Time = in hours.
[a]Pearson Product-Moment correlation: between the 2 study groups.
[b]t test (for correlated M's/SD's): for 154 df, t = 1.98/2.61 at .05/.01.
[c]Matching variable: matching by pairs design.
[d]CI group: fixed time = no variation (thus no r or SD possible).
*$p < .05$.

a. Basic Approach/Results

The results of this interim study are contained in Table 8. In consonance with the earlier studies discussed, the matching results of the two study groups was first established. Table 8 confirms that equated groups were obtained and provided a valid basis for further study. Analysis of the three criterion measures, written test I, performance test I, and time-to-complete I, is also illustrated in Table 8. The written test mean scores for the two groups were found to be equated. However, the mean performance scores were found to be significantly different, with greater achievement demonstrated in favor of the CAI group, by 3.71 points (i.e., 107.00 - 103.29). As in prior analysis presented, a substantial difference was obtained between the study groups on the time-to-complete measure. Thus, a mean score difference of 12.08 hours (in favor of the CAI group: i.e., 42.00 - 29.92) resulted, which effected a 29 % reduction (savings) in training time. Again, due to the lock step nature of CI, the lack of variation in time-to-complete training prevented computation of any correlation and t testing of significance in relation to this criterion.

b. Resume of Results

The results of this study regarding the relative performance of two different instructional methods, CAI and CI, on three separate criteria of electronics training, achievement (both written/performance tests) and time-to-complete instruction, mirrored the basic results of the feasibility study and its follow-up investigation. Thus, relative to CI performance, the findings of this interim study supported the basic feasibility findings that CAI effects equal or better achievement than CI, and in substantially less time.

4. CAI Interim Study (Wks. 1-3: 72 Hrs.)

a. Basic Approach/Results

The results of this interim study are contained in Table 9. As illustrated, the matching process yielded two equivalent groups which

Table 9

CAI vs CI: Phase II Achievement/Time
(Wks. 1-3: 72 Hrs.)

Matching/Performance Measures	r[a]	CAI M	CAI SD	CI M	CI SD	t[b] M	t[b] SD
Pred. Ph. I[c]	1.00	103.89	9.30	103.89	9.30	---	---
Written II	.43	113.18	16.35	110.67	21.27	1.70	3.21*
Time II	---[d]	50.56	16.75	72.00	---[d]	(30% Reduction)	

Note. Matching/achievement measures = standard score form. (N=121)
Time = in hours. (For this MOS ph. II = wk 3 only/no perform. test).
[a]Pearson Product-Moment correlation: between the 2 study groups.
[b]t test (for correlated M's/SD's): for 120 df, t = 1.98/2.62 at .05/.01.
for 60 df, t = 2.00/2.66 at .05/.01.
[c]Matching variable: matching by pairs design.
[d]CI group: fixed time - no variation (thus no r or SD possible.).
*$p < .01$.

provided the basis for further comparative analysis. It should be noted that, for the three Army MOS's employed (31S3, 32F2, and 36H2) in this interim study, phase II is represented entirely by week three content. The achievement criterion test for this week of training consisted only of a written test and did not entail any performance testing. Analysis of the two available criterion measures for this study, written test II and time-to-complete II, are reflected in Table 9. The written test mean scores for the two study groups were equivalent: i.e., the difference between the means was 3.16 which approached but did not attain significance. As in the previous investigations, a substantial difference was obtained between the study groups on the time-to-complete criterion. Thus, a mean time score difference of 21.44 hours (in favor of the CAI group: i.e., 72.00 - 50.56) resulted, which yielded a 30 % reduction (savings) in time.

b. Resume of Results

The results pertaining to achievement (written test only) and time-to-complete training again reflected the findings of the earlier studies in this series. Thus, the CAI group exhibited at least equal achievement and completed training in substantially less time in comparison with their counterparts in the CI group.

5. Final Summative Evaluation (Wks. 1-4: 102 Hrs.)

a. Basic Approach/Results

The culmination of this series of CAI feasibility/follow-up studies was a final summative evaluation. This study represented the cumulative in-house efforts in the development of CAI instructional materials: i.e., 102 hours of computer-based instruction consisting of both CAI (primarily) and CMI. For the purposes of analysis, the same basic study-control group design using matched groups (matching by pairs) was employed. The results of this evaluation are contained in Table 10. Again, two representative Army technical MOS's were used as the sampling basis: (a) 26V20: Strategic Microwave System Repair; and, (b) 32D20: Fixed Station Technical Controller System Repair. As indicated in Table 10, the matching process effected two equivalent groups, thus providing the basis for further treatment and analysis. The achievement criterion tests for this phase of training consisted of both a written and performance test. Analysis of these two available criteria, written test II and time-to-complete II, is contained in Table 10. Both the written and performance test mean scores for the two study groups were found to be equivalent on the basis of the t test of significance. The differences between the means were trivial: .49 and .77, respectively, and therefore nonsignificant.

Table 10

CAI vs CI: Phase II Achievement/Time
(Wks. 1-4: 102 Hrs.)

Matching/Performance Measures	r[a]	CAI M	CAI SD	CI M	CI SD	t[b] M	t[b] SD
Pred. Ph. I[c]	.99	105.68	9.14	105.57	8.99	1.94	2.71*
Written II	.40	78.72	9.80	78.23	10.01	.47	.24
Performance II	.29	85.02	8.91	84.25	10.68	.68	1.97
Time II	.10	75.82[d]	24.08	118.62[d]	31.45	11.87**	2.82*

Note. Matching/achievement measures = standard/raw scores respec'ly.
Time = in hours. (N=109)
[a]Pearson Product-Moment correlation: between the 2 study groups.
[b]t test (for correlated M's/SD's): for 108 df, t = 1.98/2.63 at .05/.01.
for 54 df, t = 2.01/2.67 at .05/.01.
[c]Matching variable: matching by pairs design.
[d]Time reduction: 36.1 % (savings).
*$p < .01$.
**$p < .001$.

Similar to the prior analyses in this series, a substantial difference was obtained between the study groups on the time-to-complete criterion. A mean score difference of 42.8 hours (in favor of the CAI group: i.e., 118.62 - 75.82) was derived which yielded a 36.1 % reduction (savings) in time. As noted above, the design of this particular summative study permitted the collecting of setback time for the CI study sample. This generated a variance measure on time-to-complete training for this control group which was lacking in the prior analyses in this series. Thus, with a time variance available for both study groups, the computation of a time criterion correlation, and thereby a mean difference test of significance between the two groups, was made possible (cf. Table 10). The latter analysis provided support to the earlier findings of a substantial reduction in time-to-complete training in favor of the CAI group. The difference of 42.80 hours between the mean time scores, reflecting a 36.1 % time reduction for the CAI group relative to the CI group, was found to be statistically significant with $p < .001$. The fact that the variance for time itself showed a significant difference between the two groups did not alter the basic finding between the two group means on time-to- complete training. Given the procedure of reducing the *df* by 1/2 in such cases, and thereby establishing a more stringent *t* level of significance (Edwards, 1954; Snedecor, 1946), the *t* test for the means still retained its high significance (cf. footnote *b* to Table 10).

b. Resume of Results

The findings of the summative study were in exact alignment with all prior results on achievement (both written and performance criteria) and time-to-complete training. Thus, the CAI group demonstrated equal achievement and completed training in significantly less time in comparison with matched CI study groups.

B. ISSUE B: Replication of Effectiveness: $CBI_{(1)}$ vs $CBI_{(2)}$

The issue primarily addressed in this section is the replication of the effectiveness of CBI as exemplified by two distinct CBI systems: the IBM 1500 Instructional System ($CBI_{(1)}$) and the PLATO IV Education System ($CBI_{(2)}$). Three areas are focused on in this issue: a determination of the commonality and differences between the two CBI systems; optimization of the operational use of CBI; and, potential CBI aspects for further research and evaluation. The results and analysis of the first area will be considered in this section, while inferences and recommendations pertaining to the latter two areas will be addressed in the following chapter. The criteria basis for analysis of this particular issue is represented by two attitude/opinion questionnaires administered separately to each CBI study group. Due to the classroom operational conditions under which the data collection was conducted, this analysis, similar to the prior issue, is classified as quasi-experimental. The evaluation scenario will include both quantitative (significance testing) and qualitative (content analysis) assessment strategies, examining the attitude results both by item as well as by total scores. Also, as with the prior issue, a summary of the attitude/opinion results for the two CBI study groups will be given. This will include for each CBI study group, a description of the approach, sampling, and test instruments employed, and a resume of the obtained findings. Specific to this analysis will be a comparison of attitudes toward the two CBI systems cited above.

1. $CBI_{(1)}$ vs $CBI_{(2)}$: Attitude Item Scale Responses

a. Basic Approach/Results

Besides several measures of achievement, the IBM 1500 study group ($CBI_{(1)}$) included a measure of attitude toward general and specific aspects of CAI (computer assisted instruction). The instrument designed to measure these attitudes consisted of two parts: comparison of CAI versus CI (11 items), and assessment of the CAI environment per se (11 items). It also included three general questions designed to elicit student opinions and suggestions (cf. Appendix E). By design this questionnaire was administered twice: after 4 weeks of CAI instruction, and, subsequently, after two weeks of CI instruction to the same students. The fourth week measure was given special focus in this project. The latter measure, of course, represented a more thorough index of CAI attitude since it included two weeks of CI material experience, giving students the opportunity to compare the relative merits of the two instructional systems. Similarly, the PLATO IV study group ($CBI_{(2)}$) included a measure of general/specific attitudes toward both CBI techniques: i.e., CAI/CMI. The instrument designed to measure these attitudes consisted of two parts also: instructional uses of PLATO IV and PLATO terminal and work area effectiveness; and, was administered to two study groups: individual-learning (I-L) and peer-learning (P-L). Likewise, this questionnaire included an opportunity for students to express their opinions and suggestions. Lastly, it should be noted that the attitude data obtained in this section is represented by cell frequency talleys associated with student responses to each attitude scale item. As categorical measures of ordinal scales therefore the appropriate test of statistical significance is the nonparametric test: Chi Square ($\underline{X}^2$).[1]

(1) CBI $_{(1)}$ Attitude Scale Results. The results of the attitude scale responses for the two CBI study groups are contained in Tables 11-14. For the sake of clarity, each of the tables includes item results for the two parallel analysis conducted on the two respective CBI systems: i.e., week 4 versus week 6 (for CBI $_{(1)}$); and, I-L versus P-L (for CBI $_{(2)}$). Thus, the results are conveniently displayed in only four tables and facilitate comparisons between the parallel conditions.

The significance of the item responses on the CBI $_{(1)}$, i.e., the IBM 1500 System, questionnaire (part I) are contained in Table 11. The $\underline{X}^2$ test of the hypothesis of equal probability across response cells (null hypothesis) was used on each item. Thus, given the 11 item questionnaire administered at the end of the fourth and sixth week of training, this yielded 22 separate $\underline{X}^2$ tests. The results indicated that: 18 of these tests were highly significant ($\underline{p} < .001$); one test was significant at $\underline{p} < .01$; and, 3 were nonsignifi . Accordingly, all item results, except the 3 nonsignificant items, were judged to be pro-CBI. Inspection of Table 11 (for full item description see Appendix E) indicates the 11 attitude areas responded to by the students. Noteworthy, by exception, is that the nonsignificant tests appeared at week 6 only. The respective areas covered by these 3 items were: "learning of electronics", "retention ease", and "given assistance" (i.e., students were impartial toward CAI/CI regarding learning new material, retention of new material and being assisted during difficulties).

The results of part II are contained in Table 12. In this instance, all

[1]Where df = 1 (in Tables 11-16), Yates correction for continuity applied.

Table 11

Attitude toward the IBM 1500 System: by Item
(Part I: Wks. 4/6)

Attitude Items	Gp.	Response Frequencies Con a	b	c	d	Pro e	df	χ^2	Pro/Con CBI
1. Learning Electronics	Wk 4:	11	17	26	36	48	4	31.46**	Pro
	Wk 6:	17	21	22	35	30	4	8.55	--
2. Retention Ease	Wk 4:	15	20	24	43	36	4	14.94*	Pro
	Wk 6:	18	21	29	30	27	4	4.40	--
3. Tailored to Needs	Wk 4:	14	16	12	37	59	4	41.88**	Pro
	Wk 6:	18	16	22	30	39	4	14.40*	Pro
4. Given Assistance	Wk 4:	15	12	27	30	54	4	39.50**	Pro
	Wk 6:	20	29	29	23	24	4	2.48	--
5. Sequence of Material	Wk 4:	6	4	28	45	55	4	74.22**	Pro
	Wk 6:	7	6	39	39	34	4	46.32**	Pro
6. Attention Facilitated	Wk 4:	9	12	12	32	73	4	104.06**	Pro
	Wk 6:	10	8	25	34	48	4	44.96**	Pro
7. Learning Atmosphere	Wk 4:		(8)[a]	14	28	88	3	149.86**	Pro
	Wk 6:	6	8	15	35	61	4	85.84**	Pro
8. Use of Training Time	Wk 4:	7	9	14	31	77	4	121.71**	Pro
	Wk 6:	13	5	24	33	50	4	49.35**	Pro
9. Interest is Stimulated	Wk 4:	7	16	29	30	56	4	49.07**	Pro
	Wk 6:	14	13	34	36	28	4	19.04**	Pro
10. Fatigue in Training	Wk 4:[b]	7	21	24	42	44	4	34.21**	Pro
	Wk 6:[b]	7	12	35	36	35	4	32.56**	Pro
11. Overall Opinion	Wk 4:	5	13	9	48	63	4	97.86**	Pro
	Wk 6:	10	15	21	44	35	4	32.08**	Pro

Note. Part I of attitude questionnaire = comparison of CAI/CI (11 items).
[a]Includes 2 *f*'s from cell "a".
[b]Cell frequencies reversed (a - e) for constancy.
**p* < .01.
***p* < .001.

Table 12

Attitude toward the IBM 1500 System: by Item
(Part II: Wks. 4/6)

Attitude Items	Gp.	Response Frequencies Pro a	b	c	d	Con e	df	χ^2	Pro/Con CBI
1. Sequence of CAI	Wk 4:	63	65	(10)			2	104.21*	Pro
	Wk 6:	52	59	8	(6)		3	101.09*	Pro
2. Reading Skill Level	Wk 4:		19	78	32	9	3	105.64*	Neut.
	Wk 6:	5	15	59	39	7	4	87.04*	Neut.
3. Style of CAI	Wk 4:	12	59	37	19	11	4	59.56*	Pro
	Wk 6:	11	56	28	24	6	4	61.12*	Pro
4. Carrel Comfort	Wk 4:	83	37	12	(6)		3	137.36*	Pro
	Wk 6:	78	33	8	(6)		3	140.92*	Pro
5. Fatigue Experienced	Wk 4:	13	65	11	42	7	4	90.00*	Mixed
	Wk 6:	10	64	16	29	6	4	88.16*	Pro
6. Helpfulness of Slides	Wk 4:	77	48	6	(7)		3	133.08*	Pro
	Wk 6:	64	37	15	(9)		3	80.84*	Pro
7. Number of CAI Frames	Wk 4:	27	85	19	7		3	134.72*	Pro
	Wk 6:	17	79	18	7	4	4	151.76*	Pro
8. Frame load	Wk 4:	37	80	12	(9)		3	121.49*	Pro
	Wk 6:	25	80	13	(7)		3	139.72*	Pro
9. Background Noise	Wk 4:	61	62	10	(5)		3	110.64*	Pro
	Wk 6:	53	52	13	(7)		3	79.24*	Pro
10. Projector Noise	Wk 4:	85	37	(16)			2	125.21*	Pro
	Wk 6:	72	29	17	(7)		3	104.52*	Pro
11. Boredom Exper.	Wk 4	111	27				1	49.92*	Pro
	Wk 6	99	26				1	41.15*	Pro

Note. Part II of attitude questionnaire = CAI milieu per se. Parenthetic entries include adjacent cell *f*'s of <4.

*$p < .001$.

22 $\underline{X}^2$ tests were significant, where in each case $\underline{p} < .001$. However, not all of the tests were in favor of CBI. Thus, the analysis demonstrated that 19 tests of item significance were pro-CBI; 2 were neutral; and, 1 was mixed (between pro/con). Item #2, identified as neutral on attitudes at both weeks 4 and 6, was "reading skill level": i.e., neither too high nor too low. Item #5, identified as mixed in attitude at week 4, was "fatigue experienced": i.e., a bimodal distribution of responses, with most responses lumped at "b" (65) and "d" (42). The other nine pro-CBI items are identified by inspection of Table 12, and more fully described in Appendix E.

(2) $\underline{\text{CBI}_{(2)}}$ Attitude Scale Results. The significance of the item responses on the PLATO IV ($\text{CBI}_{(2)}$) attitude questionnaire (part I) is contained in Table 13. Given the 14 item questionnaire administered to both the individual-learning (I-L) and peer-learning (P-L) groups, a total of 28 separate $\underline{X}^2$ tests were derived. Nineteen of these $\underline{X}^2$ tests were significant, with $\underline{p}$ levels ranging from $< .05$ to $< .001$. In all cases these significant results were indicative of pro-CBI attitudes. While 8 of the tests were nonsignificant, 4 of these were merely distinctions between "a" and "b" responses only, i.e., "highly disposed" versus "somewhat disposed" toward CBI. Thus, regardless of the $\underline{X}^2$ test outcome, these items were clearly pro-CBI. Overall, for the I-L group, 11 of the 14 items were demonstrated to be pro-CBI; while, for the P-L group, 12 of the items were found to be pro-CBI. Thus, both study groups were highly disposed toward CBI with the P-L group being only slightly more

Table 13

Attitude toward the PLATO IV System: by Item

(Part I: Gps. I-L/P-L)

Attitude Items	Gp.	Response Frequencies: Pro a	b	c	d	Con e	df	X^2	Pro/Con CBI
1. Graphics Helpfulness	I-L:	23	(12)				1	2.81	Pro
	P-L:	47	(5)				1	32.32***	Pro
2. Number of Frames	I-L:	18	(17)				1	.01	Pro
	P-L:	20	28	4			2	17.58**	Pro
3. Amount of Material	I-L:	21	(14)				1	1.03	Pro
	P-L:	25	22	5			2	13.70**	Pro
4. Sequence of Material	I-L:	25	(10)				1	5.48*	Pro
	P-L:	26	(26)				1	---	Pro
5. TV/Q's Coordination	I-L:	15	5	(4)			2	9.26**	Pro
	P-L:		19	(5)			1	7.04**	Pro
6. TV vs Computer Distr'c.	I-L:		(17)	(7)			1	3.38	---
	P-L:		(17)	(7)			1	3.38	---
7. Stopping TV Player	I-L:[a]		7	(5)		12	2	3.25	---
	P-L:[a]		(15)	(5)		4	2	9.26**	Pro
8. Lesson Length	I-L:	9	(15)				1	1.04	Pro
	P-L:		(20)	4			1	9.38**	Pro
9. Sound/Q's Coord.	I-L:	18	11	(6)			2	6.08*	Pro
	P-L:	22	21	(9)			2	6.17*	Pro
10. Projector/Q's Coord.	I-L:[a]	(8)		5	(22)		2	13.74**	Pro
	P-L:[a]	10	4	6	13	19	4	12.20*	Pro
11. Sound/Slide vs Comput.	I-L:	9	17	4	(5)		3	11.67**	Pro
	P-L:	20	18	4	(10)		3	13.51**	Pro
12. Lessons 1st/Then Q's	I-L:	22	(6)	(7)			2	13.41**	Pro
	P-L:	23	6	11	5	7	4	12.00*	Pro
13. Lesson Length	I-L:	12	15	4	4		3	10.54*	Pro
	P-L:	13	34	5			2	26.41***	Pro
14. Troubleshooting	I-L:[a]	5	4	16		(8)	3	11.13*	Neut.
	P-L:[a]	7	8	16	7	10	4	5.80	---

Note. I-L = Individual-Learning Group. Parenthetic entries: include adjacent cell f's of <4.
P-L = Peer-Learning Group.

[a]Items #7, #10, #14: Scoring (a - e) = reversed.

*$p < .05$.
**$p < .01$.
***$p < .001$.

Table 14

Attitude toward the PLATO IV System: by Item

(Part II: Gps. I-L/P-L)

Attitude Items	Gp.	Response Frequencies Pro a	b	c	d	Con e	df	χ^2	Pro/Con CBI
1. Difficulty of Terminal	I-L:		(24)		(9)		1	5.94*	Pro
	P-L:	28	(24)				1	.17	Pro
2. Keyboard Operation	I-L:[a]			5	9	21	2	11.89**	Pro
	P-L:[a]			(7)	18	27	2	14.22**	Pro
3. Presentation Delay	I-L:	20	5	4	(6)		3	19.50***	Pro
	P-L:	32	16	(4)			2	22.76***	Pro
4. PLATO Image	I-L:	22	(13)				1	1.83	Pro
	P-L:	43	8				1	22.67***	Pro
5. Screen Eyestrain	I-L:		(22)	4	9		2	14.79**	Pro
	P-L:	27	16	(9)			2	9.50**	Pro
6. Letter Size	I-L:	18	13	4			2	8.62*	Pro
	P-L:	24	22	(6)			2	11.24**	Pro
7. TV Cassette Operation	I-L:		(18)	6			1	5.04*	Pro
	P-L:	13	(10)				1	.17	Pro
8. Projector Operation	I-L:	25	4	6			2	23.04***	Pro
	P-L:	34	9	(9)			2	24.04***	Pro
9. Carrel Working Space	I-L:	13	18	(4)			2	8.63*	Pro
	P-L:	10	27	7	8		3	19.84***	Pro
10. Device Arrangement	I-L:	19	11	5			2	8.46*	Pro
	P-L:	24	(28)				1	.18	Pro
11. Carrel Lighting	I-L:		(26)	(9)			1	7.31**	Pro
	P-L:		42	(10)			1	18.48***	Pro
12. Background Noise	I-L:	18	11	(6)			2	6.24*	Pro
	P-L:	35	12	(5)			2	28.43***	Pro
13. Training Fatigue	I-L:		(28)		(7)		1	11.43**	Pro
	P-L:	17	26		(9)		2	8.35*	Pro

Note. I-L = Individual-Learning Group. P-L = Peer-Learning Group. Parenthetic entries: include adjacent cell f's of <4.

[a]Item #2: Scoring (a - e) = reverse of other items.

*$p < .05$.

**$p < .01$.

***$p < .001$.

inclined toward it than the I-L group. Also, from other points of view, 11 items indicated significant pro-CBI responses by both the two groups (I-L/P-L) jointly; one item (#7) displayed a pro-CBI attitude by the P-L group only; one item (#14) displayed a neutral position by the I-L group only; and, one item (#6) was preferred by neither of the two groups. The findings of this part of the questionnaire were thus quite clear as to predominant student acceptability toward CBI as embodied in the PLATO IV Computer-based Educational System. Inspection of Table 13 reveals the respective attitude areas relating to these findings.

The significance of the item responses on part II of the PLATO IV attitude questionnaire are contained in Table 14. This part consisted of 13 items for significance testing. As above, when administered to both the I-L and P-L training groups, this yielded a total of 26 separate $\underline{X}^2$ tests. Twenty-two of these tests were significant with $\underline{p}$ levels ranging from $<.05$ to $<.001$. In all cases, these significant results were indicative of pro-CBI attitudes. As in part I of the questionnaire, while four $\underline{X}^2$'s were nonsignificant, the results were still judged to be pro-CBI since the four cases in point were merely testing the distinction between "highly" and "somewhat" favorable toward CBI. Overall, every item received a pro-CBI endorsement by both training groups (I-L/P-L). Thus, the findings of part II of the questionnaire were unanimous on student acceptability toward CBI as exemplified by varied aspects of the PLATO IV System. Table 14, and Appendix F, reveal the respective attitude areas relating to these findings.

b. Resume of Results

The attitude questionnaire findings on the two CBI systems, the IBM 1500 System ($CBI_{(1)}$) and the PLATO IV System ($CBI_{(2)}$) are summarized in Tables 15 and 16, respectively. The results were obtained by cross item summation. Table 15 reflects the findings contained in Tables 11 and 12 relating to parts I and II of the $CBI_{(1)}$ questionnaire, with both parts being considered separately and jointly. Furthermore, information on weeks 4 and 6 of basic electronics training are included in the data summary of Table 15. As discussed in the analysis of the individual attitude

Table 15

Global Attitude toward IBM 1500 System: Cross Items

(Parts I/II: Wks 4/6)

Attitude Test Part	Wk.	Pro a	M Frequencies[a] b	c	d	Con e	df	X^2	Pro/Con CBI
I	4[b]	59	37	20	13	9	4	60.43*	Pro
	6[c]	37	34	27	14	13	4	19.72*	Pro
II	4	46	56	20	12	4	4	71.57*	Pro
	6	39	50	20	12	4	4	51.04*	Pro
I/II	4	53	47	20	12	6	4	63.93*	Pro
	6	38	42	24	13	8	4	35.68*	Pro

[a] Cell frequencies (a - e) reversed for constancy where appropriate.
[b] Week 4 $N = 138$.
[c] Week 6 $N = 125$.
* $p < .001$.

items above, Table 15 clearly illustrates the highly significant positive attitude which the students had towards the IBM 1500 CBI System. This favorable disposition showed on both parts of the attitude questionnaire and at the end of their CAI training (week 4) as well as after two subsequent weeks of CI (week 6). This summative data clearly supports the overriding inference drawn from the analysis of the individual items themselves that student attitudes were highly in favor of CBI as represented by the IBM 1500 System.

Table 16

Global Attitude toward PLATO IV System: Cross Items
(Parts I/II: Gps. I-L/P-L)

Attitude Test Part	Gp.	N	Pro a	M Frequencies[a] b	c	d	Con e	df	X^2	Pro/Con CBI
I	Indiv.	32	--	(25)[b]	(7)[b]	--	--	1	9.03*	Pro
	Peer	45	19	15	5	(5)[b]	--	3	13.79*	Pro
II	Indiv.	32	--	(28)[b]	(6)[b]	--	--	1	12.97*	Pro
	Peer	50	26	18	(6)[b]	--	--	2	11.94*	Pro
I/II	Indiv.	33	--	(26)[b]	(7)[b]	--	--	1	9.82*	Pro
	Peer	47	22	16	5	(4)[b]	--	3	19.07**	Pro

Note. Some items not answered by all S's. Thus average N per gp. varied.
[a]Cell frequencies (a - e) reversed for constancy where appropriate.
[b]Entries include adjacent cell frequencies of 3 or less.
*$p < .01$.
**$p < .001$.

Table 16 reflects the findings contained in Tables 13 and 14 relating to parts I/II of the $CBI_{(2)}$ questionnaire, both parts considered separately and together. Information on the individual and peer learning study groups are included in the data summary. As indicated in the analysis of the individual attitude items themselves, Table 16 clearly illustrates the highly significant positive attitude which the students had towards the PLATO IV

CBI System. This favorable disposition was obtained on both parts of the attitude questionnaire and for both the I-L and P-L training groups. In resume, analysis of the individual attitude item responses and their cross item summation presented strong replicative evidence between two CBI systems on the desirability and acceptability of computer-based instruction. The almost unanimous favorable disposition toward the items of the separate attitude questionnaires by the two study groups demonstrated a strong commonality between them on preferring CBI.

2. $CBI_{(1)}$ vs $CBI_{(2)}$: Expressed Opinions

a. Basic Approach/Results

Besides Likert items, both questionnaires included selected open ended items designed to elicit student comments regarding the respective CBI systems. The response to these items was typically varied. While certain items drew only a few comments, other items elicited comments from the entire sample. These expressed comments were subjected to a content analysis which yielded a variety of dimensions and sub-areas of attitude and opinion toward CBI. The relative importance of each dimension/sub-area was determined solely by the empirical evidence of comments tabulated for each area. The student responses were voluntary comments to two separate perspectives to CBI: global attitude toward CBI, and specific attitude toward individual CBI areas of interest. By design, it was intended that the general vice specific items, as well as the Likert versus open ended item format discussed earlier, would complement one another for a more thorough view of student attitude/opinions toward CBI.

The results pertaining to the generalized expressed comments by the IBM 1500 ($CBI_{(1)}$) sample are contained in Tables 17-19; and, the results of the generalized expressed comments relating to the PLATO IV ($CBI_{(2)}$) sample are contained in Tables 20-21. Regarding student expressed comments toward specific attitude items, solicitation of comments was productive for the $CBI_{(2)}$ sample only. The latter findings are contained in Tables 22-23. For appropriate attitude interpretation, it should be noted that the training context for the $CBI_{(1)}$ group consisted of an intensive four week CAI course on basic electronics, while the $CBI_{(2)}$ group consisted of a set of mini-lessons on similar subject matter and representing about 6 hours of classroom material. For both situations, most subject matter was taught on-line, with occasional segments (performance exercises and other material) being taught off-line. In both cases, the student sample consisted of regular Army enlisted personnel who were commencing basic electronics training. As noted in earlier sections, the study setting was a real-time operational one. The basic expressed opinion results are presented in sections (1)-(3) below.

(1) <u>General Comment Areas: $CBI_{(1)}$</u>. The $CBI_{(1)}$ was asked three generalized opinion questions as indicated by items 12, 13 and 14 of Appendix E (part II). These questions concerned: comparison of CBI with CI; things liked most about CBI; and, things disliked most about CBI. The findings are as follows.

Table 17

Expressed Comments on CBI vs CI: General

(IBM 1500 Gp.)

Generic/Sub Opinion Areas	Pro CBI f[a]
o Individualized/Self-Paced Method	
-Prefer self-paced method	15
-Provides more attention	2
-Have own equipment	2
-Have own "Instructor"	2
-Provides independent training	2
	23
o Training Conditions/Milieu	
-More comfortable	14
-Less boring	5
-Less distraction	1
-Less tiring	1
	21
o Miscellaneous Opinions	
-Can use time better	3
-Covers course well	2
-Better than good instructor	1
-Sticks to subject well	1
-Instructor is more free	1
-Material is well planned	1
-Can take notes easier	1
-Increases retention	1
-Better as a teaching aid	1
-Permit S's[b] to choose CAI	1
-Use more CAI	1
	14
o General Disposition	
-More effective than CI	1
-Holds interest more	
-Can learn faster with CAI	5
	37
	95

Generic/Sub Opinion Areas	Pro CI f[a]
o Inquiry/Interactive Potential	
-Better for asking Q's	14
-Facilitates reviewing	3
-Facilitates discussion	1
-Good for tutoring	1
-Promotes interaction of S's	1
-Facilitates S[b]/I[c] interaction	1
	21
o Miscellaneous Opinions	
-Requires less pre-knowl'ge	1
-Gives less but enough info.	1
-Requires less verbal skills	1
-Is more informative	1
-Requires no back-up as CAI	1
-Is more specific	1
-Facilitates retention	1
-Is not superficial on details	1
	8
o Fatigue	
-Requires less patience	2
-Not repetitious as frames	2
-Not tiresome as CAI	1
	5
o General Disposition	
-CI is better	6
-CAI/CI value varies with S	1
-Both CAI/CI are are bad	1
	8
	42

[a] f = frequency count.
[b] S = Student(s).
[c] I = Instructor.

(a) Comment Area: CBI vs CI. The results of the first question are contained in Table 17. By design, the expressed comments fell into two categories, pro-CBI (denoting CAI primarily) and pro-CI. Overall, it is noteworthy that the majority of the responses (69%) were pro-CBI. Inclusively, of these, a total of 95 pro-CBI comments were subdivided into: general disposition (37); training conditions/atmosphere (23); individualized self-paced approach (21); and, miscellaneous (14). Within these, based on the comparison with CI, specific emphasis was placed on the following item topics: CBI is more effective (18); CBI provides more comfortable training (16); prefer self-paced CBI (15); and, CBI holds one's interest (14). Conversely, 31% of the responses were pro-CI. In this regard, a total of 42 expressed comments were obtained. These were subdivided into the broad areas of: inquiry/interactive potential (21); general pro/con comments (8); specific pro/con comments (8); and, fatigue (5). Regarding these broad opinion areas, emphasis was placed on the following topical areas: CI facilitates asking questions (14) and reviewing/interacting with instructor and other peers (7 total). Other comments were expressed but were not supported with any large concensus of opinion.

(b) Comment Area: Positive Aspects of CBI. The results of the second question, regarding what is liked most about CBI, are contained in Table 18. The total number of comments made on this question was 157. The logic of these comments yielded the following four opinion categories and their respective frequencies: CBI (i.e., CAI)

Table 18

Expressed Comments on What Students Like about CBI: General (IBM 1500 Gp.)

Generic/Sub Opinion Areas	f[a]
o CBI Milieu	
o Training Conditions/Atmosphere	
-Good learning environment	22
-Informal conditions	18
-Comfortable conditions	16
-Air Conditioning	12
-Smoking in class	5
-Quiet conditions	5
-Good training hours	3
-Training breaks	1
-Very personal treatment	1
-Not boring	1
	84
o CBI Instructional Methodology	
o Individualized/Self-Paced Method	
-Like learning at own rate	36
-Have own equipment	4
-Make better use of time in CAI	2
-Similar to self-tutoring text	1
-Instruction is more personalized	1
-Can learn faster with CAI	1
-Like the style of CAI	1
	46
o Course/Lesson Material	
-Course presentation is good	4
-Can learn easier with CAI	3
-Lessons ordered logically	1
-Quizzes are related well to course	1
-Like the practical exercises	1
	10
o CBI Equipment	
-CAI terminal is effective	1
-Keyboard entry is good	1
	2
o General Disposition	
-Like everything about CBI	9
-Like few things/nothing about CBI	6
	15
	157

Note. The IBM System = CAI primarily/with some CMI.
[a] *f* = frequency count.

milieu (84); instructional methodology (56); general comments (15); and, CAI equipment (2). Thus, the opinion category receiving the most attention was "CBI milieu" (54%); and, the other area given most focus was "instructional methodology" (36%). Within these two topics, the sub-areas students most liked about CBI were: learning at one's own rate (36); good learning atmosphere (22); and, comfortable conditions (16).

(c) Comment Area: Negative Aspects of CBI. The results of the third question, concerning what is disliked most about CBI, are contained in Table 19. The total number of comments made was 102. These comments yielded six broad opinion categories and their respective frequencies as follows: instructional methodology (41); CBI instructors (11); CBI (i.e., CAI) milieu (10); CBI equipment (9); miscellaneous comments (8); and, an assortment of general comments (23). Within these opinion areas, the specific topics receiving the most attention were: course presentation is too fast (8); poor instructor attitude (8); learning level too difficult (7); too many hours via CAI (6); and, can't repeat frames (5). Noteworthy among all the responses made was the general comment that nothing was disliked about CBI (23).

(2) General Comment Areas: $CBI_{(2)}$. The $CBI_{(2)}$ study group was asked one general question as indicated by item 14 in Appendix F. This question addressed student opinion toward CBI over an extended period of time. The findings were subdivided first according to the two PLATO study groups (I-L/P-L) and next according to the respective subtopic areas of expressed opinion (cf. Tables 20-21).

Table 19

Expressed Comments on What Students Dislike about CBI: General

(IBM 1500 Gp.)

Generic/Sub Opinion Areas	f[a]
o CBI Instructional Methodology	
o Course Content	
-Too many hours on CAI	6
-Too much reading	4
-Too much detailed information	3
-Lessons are long/boring	1
-Too much homework	1
-Need more time on Q's	1
	16
o Course Presentation	
-Too fast	8
-Instructor called too fast/often	1
	9
o Course Level	
-Learning is difficult	7
-Too competitive	1
	8
o Course Review	
-Can't repeat frames	5
-Can't ask Q's	3
	8
o CBI Instructors	
-Poor instructor attitude	8
-Can't get instructor's attention	2
-Need more instructors	1
	11
o CBI Milieu	
o Training Conditions	
-Too confined/isolated	4
-Change class hours	2
-Too tiring	1
-Too quiet/boring	1
-Background noise	1
-Light pen use is tiresome	1
	10
o CBI Equipment	
-Downtime is annoying	9
	9
o Miscellaneous Opinions	
-Need more Performances Exercises	3
-Reviews easy/tests hard	3
-Too impersonal/repetitious	2
	8
o General Disposition	
-Nothing Disliked	23
	102

Note. The IBM System = CAI primarily/with some CMI.
[a]f = frequency count.

(a) Comments by the I-L Group. The results for the I-L study group are contained in Table 20. A total of 57 I-L student comments were obtained. These comments yielded four opinion categories and their respective incidence as follows: CBI training (general) (45); fatigue (6); carrel configuration (1); and, a set of miscellaneous comments (5). As indicated, the predominant area of opinion was the generalized area of CBI training which attracted 79% of the comments. Within the opinion categories, the following specific topics were of prime interest: CBI is a good teaching system (15); self-pacing is fine (7); and, need more instructor support (6). The remaining subtopics were not supported by any sizeable concensus of agreement by the student sample to be noteworthy.

(b) Comments by the P-L Group. The results of the P-L study group are contained in Table 21. A total of 108 expressed comments were obtained. These comments yielded four broad opinion categories and their respective frequencies as follows: CBI training (general) (72); carrel configuration (17); fatigue problems (11); and peer/individual learning (8). Quite clearly, the major opinion areas of interest were the positive and negative aspects of CBI training (67%). Within these opinion categories, the highest incidence of comments centered around the following subtopics: CBI is a good teaching system (17); the carrels are too small (17); can work better at one's own pace (11); CBI is better than an instructor (11); CBI (specifically CAI) is boring over an extended time (9); and, an instructor is needed with CBI (8). The remaining subtopics did not draw enough support to be given further special mention.

Table 20

Expressed Comments toward CBI: General
(PLATO IV: I-L Gp.)

Generic/Sub Opinion Areas	f^a
o CBI: Positive/Negative Aspects	
o Positive Aspects	
-Good teaching system	15
-Self-pacing is fine	7
-Good for taking notes	2
-Less boring than instructor	2
-Keeps you busy	1
-F[illegible]ise via computer helps learning	1
-All students get Q's via CBI	1
-Instructor is more free	1
	30
o Negative Aspects	
-Need more instructor support	6
-Training hours too long	2
-CBI requires other media too	2
-Some topics require more CBI time	2
-Just reading (CAI) is not good	2
-Computer talks back too much	1
	15
o Fatigue	
-Fatigue is not a problem	3
-More breaks will reduce fatigue	2
-Fatigue is a problem	1
	6
o Miscellaneous Opinions	
-Permit students to back up on CAI	2
-Permit students to ask Q's on CAI	1
-Motivation is more important than method	1
-CAI requires greater attention/concentration	1
	5
o Carrel	
-Carrel is too small	1
	57

Note. The PLATO System = CAI primarily/with some CMI, CDI.
[a]f = frequency count.

Table 21

Expressed Comments toward CBI: General
(PLATO IV: P-L Gp.)

Generic/Sub Opinion Areas	$\underline{f}^a$
o CBI: Positive/Negative Aspects	
o Positive Aspects	
-Good teaching system	17
-Can work at own pace	11
-Better than instructor	9
-Holds attention well	4
-Ideal if desire to learn	2
-Not boring	1
-Faster learning possible	1
	45
o Negative Aspects	
-Boring over extended time	9
-Need instructor also	8
-Need better chairs	5
-Need more variety in media	3
-Too much reading	1
-Instructor is better	1
	27
o Carrel	
-Carrel is too small	17
o Fatigue	
-Causes eye fatigue	4
-Get sleepy reading too much	3
-Get tired of sitting	2
-Need more breaks	2
	11
o Peer/Individual Learning	
-Peer learning is fine	4
-Individual learning is OK	4
	8
	108

Note. The PLATO System = CAI primarily/with some CMI, CDI.
[a] $\underline{f}$ = frequency count.

(3) Specific Comment Areas: $CBI_{(2)}$. As indicated earlier, the $CBI_{(1)}$ study group was not productive of expressed comments to individual attitude items. As shown in Tables 22-23 even the $CBI_{(2)}$ study group did not express very many comments on the specific attitude items. This is so because such comments were purely voluntary. It can be assumed that expression of comments reinforces their value regardless of the total number obtained. Given this limitation, the $CBI_{(2)}$ opinions derived from the specific attitude items are available for review and analysis in this section. The items referenced here are contained in parts I/II of the PLATO IV attitude questionnaire as indicated in Appendix F. The expressed comments were summarized along two perspectives: the study groups involved (I-L/P-L) and opinion categories.

(a) Comment Area: CBI Strategies. The results for the I-L/P-L study groups regarding their expressed opinions toward three specific CBI strategies (CAI/CMI/CDI) are contained in Table 22. A total of 58 comments were obtained. These were categorized both according to the two study groups and the three CBI strategies as follows: the I-L group: three D. C. Fundamentals lessons (9); one First Aid lesson (3); and, one Troubleshooting lesson (12), (representing CAI/CMI/CDI type lessons respectively); and, for the P-L group: (ibidem) 15, 6, and 11, respectively. Noteworthy among the I-L opinion subtopics were: prefer questions throughout CBI lessons - not just at the end (10) and graphics are very helpful (5). Likewise, noteworthy among the P-L opinion subtopics were: require more material in electronics (7) and graphics are

Table 22

Expressed Comments within Three CBI Strategies: Specific (PLATO IV: I-L/P-L Gps.)

Lessons/Strategies	Study Group Comments	f[a]
	A. Individual-Learning Group	
o Three D.C. Fund. Lessons. (CAI) (Items 1-4)[b]	-Graphics very helpful	5
	-Require more hours on Ohms Law/Resistance/ Parallel Circuits	4
		9
o One 1st Aid/Safety Lesson. (CMI) (Items 5-8)[b]	-Length of lessons OK	4
o One Troubleshooting Lesson. (CDI) (Items 9-14)[b]	-Q's throughout lesson better than all at end	10
	-Slide labels useful to synchronize projector/ computer Q's	2
		12
		25
	B. Peer-Learning Group	
o (Ibidem)	-Graphics very helpful	5
	-Too few frames on D.C. Fundamentals	7
	-Too much superfluous material	4
		16
o (Ibidem)	-Lessons too long	3
	-Lessons too short	3
		6
o (Ibidem)	-Q's throughout lessons better than just at the end	7
	-Too much repetition	4
		11
		58

Note. CBI strategies (CAI/CMI/CDI): defined in glossary.
[a]f = frequency count.
[b]Cf. Part I of PLATO attitude questionnaire: Appendix F.

very helpful.

(b) <u>Comment Area: $CBI_{(2)}$ Terminal/Milieu</u>. The results for the I-L/P-L study groups on their opinions of the CBI PLATO IV terminal/milieu are contained in table 23. A total of 63 comments were obtained between the two study groups. As in the preceding section, these comments were subdivided according to the two study groups and the opinion areas relating to the PLATO IV terminal and work areas as follows: the I-L group: fatigue (11); and, terminal/work area (15); and, the P-L group: fatigue (12); and, terminal/work area (25). Noteworthy among the I-L opinion subtopics were: more frequent breaks needed (4); glare on screen bad (4); eye fatigue (3); and, more orientation on equipment use desired (3). In contrast, noteworthy among the P-L opinion subtopics were: carrel is too small (12); sitting sessions too long (4); eye fatigue (3); more orientation needed on keyboard use (3). Other comments receiving less emphasis than those just stated are contained in Table 23 for inspection.

b. Resume of Results

The findings on the student expressed comments indicated a number of general areas and specific topics of student interest and concern. Included in the findings were both positive and negative aspects of CBI. A variety of comments were generated by the open ended format of the attitude/opinion questionnaires for the $CBI_{(1)}$ (IBM System) and $CBI_{(2)}$ (PLATO System) study groups. Based on the highest incidence of comments obtained on the $CBI_{(1)}$ questionnaire, the prime areas/topics noted are

Table 23

Expressed Comments toward CBI Terminal/Milieu: Specific

(PLATO IV: I-L/P-L Gps.)

Generic/Sub Opinion Areas	*f*[a]
A. Individual-Learning Group	
o Terminal/Work Area	
-Too much glare on screen	4
-Letter size too small	2
-Carrel space is sufficient	1
-Carrel lighting is poor/ room noisy	2
-Need more information on equipment use	3
-Use TV cassette throughout lesson	1
-Improve slides	1
-Computerized training is too fast	1
	15
o Fatigue	
-More frequent breaks needed	4
-Eye fatigue experienced	3
-Mental fatigue experienced	2
-Sitting sessions are too long	1
-No fatigue experienced	1
	11
B. Peer-Learning Group	
o Terminal/Work Area	
-Carrel is too small	12
-2ndary devices built-in too low	1
-Need more information on keyboard use	3
-Need frame backspacer	2
-Too much glare on screed	2
-Zeroes look like o's	1
-Letter size is OK	1
-Room is noisy	1
-Room is too cold	1
-Terminal downtime was annoying	1
	25
o Fatigue	
-Sitting sessions too long	4
-Had eye fatigue with CRT/slide projector	3
-CBI was not boring	3
-Degree of boredom same as with CI	2
	12
	63

Note. The PLATO System = CAI primarily/with some CMI, CDI.

[a] *f* = frequency count.

ranked as follows: (a) CBI vs CI positive aspects: CBI is more effective than CI, CBI atmosphere is better for learning, students prefer self-paced learning, CBI holds one's interest; and, negative aspects: CBI is not suitable for asking questions/review of material (i.e., CAI specifically as it was designed for administration to these two study groups. Other available configurations circumvent these problems); (b) CBI preferences: like CBI self-paced method, like CBI training conditions (informal/comfortable); and, (c) CBI dislikes: instruction is too fast, poor instructor attitude, and learning level is difficult. Similarly, based on the $CBI_{(2)}$ questionnaire, the prime areas/topics for the I-L/P-L groups are as follows in rank order of importance: (a) I-L group: CBI is a good teaching system, self-pacing is fine, and need more instructor support; and, (b) P-L group: CBI is a good training system (PLATO IV), self-pacing is fine, CBI is better than an instructor, CBI can be boring if too long, and instructor support is needed.

The above findings were derived from student responses to a few generalized type questions addressing global pro's and con's of CBI. Also included in the CBI questionnaires were a number of select items directed at varied specific aspects of CBI (as exemplified by the IBM 1500/PLATO IV Systems). Voluntary expressed comments to these items were likewise tabulated and pooled into cluster areas/topics of opinion. These findings are distinguished by study group (individual/peer learning modes) and item subset. As explained earlier, the $CBI_{(1)}$ group provided no substantive comments to report. Thus, the below results reflect the $CBI_{(2)}$

group opinions only. The essential results relating to part I of the $CBI_{(2)}$ questionnaire are given in rank order as follows: (a) I-L group: questions are preferred throughout lessons not just at the end, and graphics are very helpful; and, (b) P-L group: need more material on electronics, and graphics are very helpful. The prime results relating to part II of the same questionnaire are given in rank order of importance as follows: (a) I-L group: more frequent breaks needed, and too much glare on the screen, (also some emphasis given to eye fatigue and need for more orientation on equipment use); and, (b) P-L group: carrel too small (due to peer training two students occupied a carrel at once, thus being overcrowded), and need more orientation on keyboard use.

C. ISSUE C: Factors/Relationships Unique to CBI

The issue addressed in this section is concerned with the factors and relationships unique to CBI. Due to the infancy of CBI, insight into the factors associated with it, for possible manipulation and control, is as yet in the exploratory stage. Three areas are given focus in this section: an identification and description of pre/on-going training parameters relating to CBI; inferences for optimizing CBI operationally; and, potential CBI aspects for further research and evaluation. The results and analysis of the first area will be considered in this section. These will serve as the bases for inferences and recommendations to follow. The design basis for analysis of this issue consisted of four major training criteria: achievement (written/performance), completion time and pass/fail incidence. The evaluation approach will basically consist of a quantitative (correlational) analysis of all the available pre/on-going training measures for the CBI(1) (IBM 1500) study group. This group was selected because it provided the more representative sampling of students (N=139), course material, and course variables. As with the prior two issues, a summary of the simple/multiple correlational results will be given. This will include a description of the approach, sample of students and course material employed, and a resume of the obtained findings.

1. CBI Relationships: Simple Correlations

a. Basic Approach/Results

Besides the analysis of achievement and attitude measures presented in Issues A and B above, a correlational analysis of these measures yet remains to determine those factors and relationships peculiar to CBI. The classical techniques of correlational analysis, both simple and multiple linear regression, were selected to uncover these relevant aspects of CBI. The simple relationships among the available measures, including their means and standard deviations, are contained in this subsection; the multiple relationships, including factors specific to predicting each of the major criteria, are contained in the next subsection (C, 2).

The sample consisted of 139 enlisted regular Army students participating in the Army's Basic Electronics course. The CBI course segment consisted of the first two weeks of basic electronics (i.e., 42 hours). Twelve pre/on-going training measures were obtained on all CBI students. (cf. Glossary for a variable listing/definition). These consisted of eight predictor and four criterion variables which were subjected to a correlational analysis which follows below. The basic correlation matrix for the 12 variables is contained in Table 24. Noteworthy among the 66 correlation coefficients (Pearson Product-Moment) generated was the high relationship of the predicted score variable itself (-.68 to .63) with each of the four criteria. The next highest set of correlations in order of magnitude with each of the criteria was the Army Aptitude Electronics Score (-.56 to .50). With respect to the latter measure, it should be noted that it formed the basis for the predicted score variable itself. Thus, as indicated in Table 24, the correlation between these two variables is quite high at .79. Remarkably, the next two best predictors are the attitude measures, attitude-1 and attitude-2, with validity coefficients ranging from -.17 to .37 between these two variables respectively and the four criteria. The correlation between the attitude measures was .49. The variables of education and written test time rank next highest in correlation with the criteria, with coefficients ranging between -.15 to .32. Lastly, the performance test time variable demonstrated low or no correlation with the criteria (-.03 to .09). Regarding the intercorrelations among the predictor variables themselves, it is interesting to note that except for the two coefficients noted above (i.e., .79 and .49), the remaining coefficients are uniformly low (-.24 to .31). As will be seen in the following section, these low predictor correlations are advantageous toward contributing unique variance in the derivation of multiple $\underline{R}^2$ (matrix variance explained) for each of the four criteria treated separately.

Table 24

Correlation Matrix: Phase I Variables

($\underline{N}$ = 139)

Variables	2	3	4	5	6	7	8	9	10	11	12	M	SD
1. Age	.11	.04	-.02	.09	.20	.12	.15	.04	.00	-.03	-.07	20.24	2.43
2. Educ.		.16	.31	.03	-.08	-.14	-.08	.32	.22	-.22	.17	12.26	1.38
3. Elec.			.79	.05	.05	-.12	-.04	.50	.45	-.56	.28	119.33	12.65
4. Pred.				.14	.11	-.24	-.14	.63	.60	-.68	.43	102.64	10.44
5. Attit.-1					.49	.05	.07	.32	.33	-.17	.20	46.75	9.41
6. Attit.-2						-.04	.00	.37	.31	-.29	.23	41.79	4.89
7. Writ.-Time							.24	-.15	-.21	.25	-.20	61.83	11.90
8. Perf.-Time								-.01	-.03	.09	.05	59.49	5.49
9. Writ.-I									.78	-.67	.69	77.42	13.92
10. Perf.-I										-.68	.71	80.88	13.31
11. Time I											-.56	34.76	15.30
12. Pass/Fail I												.88	34

*For $\underline{N}$ = 139, $\underline{p}$ = .05 where $\underline{r}$ = .16.
**For $\underline{N}$ = 139, $\underline{p}$ = .01 where $\underline{r}$ = .21.

Variables 1-3 (cf. Table 24) are designated as pre-CBI measures since they are derived from the student's Army Basic Test Battery record; variable 4 a predicted score based on a regression designed to predict student phase I performance in basic electronics. Variables 5-8 represent other training measures available on all students through special testing. Variables 9-12 are the four official criteria of student performance. Besides the simple intercorrelations, Table 24 provides means and standard deviations on all 12 variables for inspection.

b. Resume of Results

A total of 66 correlations were obtained from the matrix of 12 variables. These measures consisted of the following: three pre-training variables, one predicted score, two affective measures, two test time measures and four training criteria. As expected, the best predictor was the predicted score itself based on a regression equation derived on an earlier student sample and cross-validated. The remaining predictors were listed successively in rank order of their importance toward predicting the criteria. Further, it was noted that the predictor variables as a whole exhibited low correlations among themselves. This represented a b[illegible] for the subsequent multiple regression analysis since low interrelated predictors bear a high potential for contributing unique variance in the derivation of multiple $\underline{R}^2$ (criterion variance explained). Finally, further description of the pre/on-going CBI parameters was presented through their respective means and standard deviations

2. CBI Relationships: Multiple Correlations

a. Basic Approach/Results

As noted above, besides simple descriptive correlations, a more comprehensive analysis of CBI factors and relationships requires an examination of the variable correlation matrix from a multiple correlational point of view. The same student sample and variable set as discussed immediately above is used. The correlation matrix was subjected to a Wherry-Doolittle Test Selection procedure which is a modified form of the Doolittle complete solution of a correlation matrix for the computation of multiple $\underline{R}^2$ (variance explained). Effectively, the Wherry-Dolittle procedure determines the minimum number of variables to predict a criterion while attaining the maximum $\underline{R}^2$ possible within a given matrix. The variables selected under this procedure contain non-overlapping variances and, as such, are considered unique - specific predictors of a given criterion. Garrett (1958) describes and outlines the Wherry-Dolittle procedure within the context of test selection where a small battery of tests is desired for effective prediction purposes. The multiple linear regression analysis was conducted through the statistical package of the PLATO IV Computer-based Educational System, located at the Computer-based Educational Research Laboratory of the University of Illinois. Besides $\underline{R}^2$, the array of regression statistics is also presented. This includes: shrunken $\overline{R}^2$, raw score weights ($\underline{b}$'s), standard score weights ($\underline{B}$'s), standard errors of both $\underline{b}$ and $\underline{B}$, constant/intercept ($\underline{K}$), and analysis of variance (ANOVA) summary of regression vice error variance explained. Since the analytic scenario for Wherry-Doolittle computation of $\overline{R}^2$ involves several regression steps, of which the final step is of most interest, the below discussion will present only the final regression statistics for each of the four training criteria assessed. The full stepwise regression analysis for each of the criteria is contained in Appendix I . A summary Table containing the main results of each Wherry-Doolittle iteration will suffice for discussion purposes.

Table 25

Final Step of Stepwise Regression Analysis: I
Criterion: Written Test I
(S 4)

Regression Factors	Statistics	Selected Measures	Variable[a]
(Sample N)	(139)	Criterion Used	9
Residual Variance	94.69[illegible]	Predictor Entered	5
Residual $S.D.$	9.73[illegible]		
Std. Error of Mean	.82[illegible]		
Multiple R	.725		
Multiple R^2	.525		
Shrunken $\overline{R}^2$	.515		
Constant (Intercept)	-59.000		

ANOVA of Regression Analysis I

Source	SS	df	MS	F
Regression	14051.12	4	3512.78	37.10
Error	12688.59	134	94.69	

[a] Cf. Table 24.

(1) Criterion 1: Written Test. The final step (#4) results of regression analysis I, employing the written test as the criterion, are contained in Table 25. As indicated, the magnitude of the multiple correlation (R) attained was .725 which translates into R^2 = .525 for the degree

of criterion variance explained. The ANOVA results for the final step of this regression analysis was highly significant with an F of 37.10, where $df = 4, 134$ and $p < .001$.

Table 26

Summary of Stepwise Regression Analysis: 1
Criterion: Written Test I

Regression Steps	Cumulative R	R^2	Shrunken $\bar{R}^2$
1	.630	.397	.397
2	.699	.488	.485
3	.719	.517	.510
4	.725	.525	.515

Variables Selected Final Step (4)[a]	b Weight	Constant (Intercept)	B Weight
Pred. Score	.708		.531
Attit.-2	.778		.273
Educ.	1.756		.174
Attit.-1	.158		.107
		-59.00	

Regression Equation (Raw Score) $Y = .708X_4 + .778X_6 + 1.756X_2 + .158X_5 - 59.00$

[a] Variables rearranged in rank order of their B weights.

A summary of the complete stepwise regression for this criterion is contained in Table 26. With each successive step, it can be seen how the cumulative R increased with the addition of other predictor variables providing unique variance to criterion prediction. Thus, R increased from .630 in step 1 to .725 in step 4, at which point overlapping of variance explained with the other predictors in the variable set was achieved at the level indicated by the shrunken $\bar{R}^2$ of .515. Also contained in Table

26 are the raw (b) and standard (B) score weights for the predictor set selected. The raw score weights form the basis for directly predicting the criterion (written test I) as effected by the regression equation contained in Table 26. This equation is perhaps the single most practical/ operational end result of regression analysis. In contrast, the B weights provide an index for appraising the relative value of the selected battery of predictors. For example, for the purpose of predicting the criterion, the predicted score variable (B=.531) is approximately twice as effective as Attitude-2 and five times more so than Attitude-1. It should be noted that in this and succeeding Tables the predictor set selected for each criterion is ranked in an order of variable effectiveness (size of B weights).

Table 27

Final Step of Stepwise Regression Analysis: II
Criterion: Performance Test I
(Step 3)

Regression Factors	Statistics	Selected Measures	Variable[a]
(Sample N)	(139)	Criterion Used	10
Residual Variance	100.994		6
Residual S.D.	10.050		
Std. Error of Mean	.852		
Multiple R	.665		
Multiple R^2	.442		
Shrunken R^2	.434		
Constant (Intercept)	-23.530		

ANOVA of Regression Analysis II

Source	SS	df	MS	F
Regression	10813.32	3	3604.43	35.69
Error	13634.19	135	100.99	

[a]Cf. Table 24.

(2) Criterion 2: Performance Test I. The final step (#3) results of regression analysis II, using the performance test as the criterion, are contained in Table 27. As indicated, the R attained was .665 which translated to an R^2 of .442 (variance explained). The ANOVA results for this regression step was highly significant with an F of 35.69, where df = 3, 135 and $p < .001$.

Table 28

Summary of Stepwise Regression Analysis II
Criterion: Performance Test I

Regression Steps	Cumulative R	R^2	Shrunken $\bar{R}^2$
1	.600	.360	.360
2	.649	.422	.418
3	.665	.442	.434
Variables Selected Final Step (3)[a]	b Weight	Constant (Intercept)	B Weight
Pred. Score	.711		.558
Attit-1	.242		.171
Attit-2	.448		.165
		-23.53	
Regression Equation (Raw Score)	$Y = .711X_4 + .242X_5 + .448X_6 - 23.53$		

[a]Variables rearranged in rank order of their B weights.

A summary of the complete stepwise regression for this criterion is contained in Table 28. The cumulative R ranged from .600 in step 1 to .665 in step 3. The corresponding increments in R^2 and $\bar{R}^2$ are likewise included in this Table. Also noteworthy is the raw score regression equation to predict the criterion; and, the fact that again the predicted score variable contributed most to criterion prediction, and both attitude measures were selected. The repeated selection of both attitude measures underscores their value in CBI.

(3) Criterion 3: Time to Complete I. The final step (#3) results of regression analysis III, using completion time as the criterion are contained in Table 29. The maximum $\underline{R}$ attained was .719 through

Table 29

Final Step of Stepwise Regression Analysis: III
Criterion: Completion Time I
(Step 3)

Regression Factors	Statistics	Selected Measures	Variable[a]
(Sample $\underline{N}$)	(139)	Criterion Used	11
Residual Variance	115.641	Predictor Entered	7
Residual $\underline{S.D.}$	10.754		
Std. Error of Mean	.912		
Multiple $\underline{R}$	.719		
Multiple $\underline{R}^2$	.517		
Shrunken $\bar{\underline{R}}^2$	.510		
Constant (Intercept)	153.530		

ANOVA of Regression Analysis III

Source	$\underline{SS}$	$\underline{df}$	$\underline{MS}$	$\underline{F}$
Regression	16692.92	3	5564.30	48.12
Error	15611.40	135	115.64	

[a]Cf. Table 24.

the joint contribution of unique variance from three predictors. This translates into an $\underline{R}^2$ of .517 (variance explained). The ANOVA results for this regression step was highly significant with an $\underline{F}$ of 48.12, where $\underline{df} = 3, 135$ and $\underline{p} < .001$.

A summary of the complete stepwise regression for this criterion is contained in Table 30. The cumulative R ranged from .680 in step 1 to .719 in step 3. The other regression by-products are included in this Table: R^2, $\bar{R}^2$, the b and B weights, and raw score regression equation

Table 30

Summary of Stepwise Regression Analysis: III
Criterion: Completion Time I

Regression Steps	Cumulative R	R^2	Shrunken $\bar{R}^2$
1	.680	.462	.462
2	.714	.509	.506
3	.719	.517	.510
Variables Selected Final Step (3)[a]	**b Weight**	**Constant (Intercept)**	**B Weight**
Pred. Score	-.930		-.635
Attit. 2	-.687		-.217
Writ. Time	.114		.089
		153.53	
Regression Equation (Raw Score)	$Y = -.930X_4 - .687X_6 + .114X_7 + 153.53$		

[a]Variables rearranged in rank order of their B weights.

to predict the criterion (completion time I). As with regression analysis I/II, the predicted score and attitude measure (i.e., attit-2) were selected as the major unique predictors of the criterion. Again, it is apparent that the predicted score variable ranked first in effectiveness, being 3 times better than attitude-2 and 7 times better than the written time measure (i.e., testing time). Again, noteworthy for predicting CBI criteria was the appearance of student attitude in the regression analysis.

(4) Criterion 4: Pass/Fail I. The final step (#5) results of regression analysis IV, using pass/fail as the criterion, are contained

Table 31

Final Step of Stepwise Regression Analysis: IV
Criterion: Pass/Fail I
(Step 5)

Regression Factors	Statistics	Selected Measures	Variable[a]
(Sample N)	(139)	Criterion Used	12
Residual Variance	.089	Predictor Entered	1
Residual S.D.	.299		
Std. Error of Mean	.025		
Multiple R	.507		
Multiple R^2	.257		
Shrunken $\bar{R}^2$	.235		
Constant (Intercept)	1.120		

ANOVA of Regression Analysis IV

Source	SS	df	MS	F
Regression	4.10	5	.82	9.21
Error	11.85	133	.08	

[a]Cf. Table 24.

in Table 31. The maximum R attained was .507 with the joint contribution of five predictors. Thus, the criterion variance explained by this predictor set is represented by an R^2 of .257. The ANOVA results for this regression step was highly significant with an F of 9.21, where df = 5, 133 and $p < .001$.

A summary of the complete stepwise regression for this criterion is contained in Table 32. The cumulative R ranged from .430 in step 1 to .507 in step 5. The other regression by-products are also included in this Table. Noteworthy among these indices is the B weight ranking of the predictor set of variables selected to predict the criterion of pass/

fail (i.e., phase I of basic electronics). As with the previous three regression analyses above, the two top predictors of CBI pass/fail were the predicted score and attitude-2. The value of statistically designed predicted scores and student attitude toward CBI were clearly demonstrated in the above analyses.

Table 32

Summary of Stepwise Regression Analysis: IV
Criterion: Pass/Fail I

Regression Steps	Cumulative $\underline{R}$	$\underline{R}^2$	Shrunken $\bar{\underline{R}}^2$
1	.430	.185	.185
2	.468	.219	.213
3	.480	.230	.219
4	.496	.246	.229
5	.507	.257	.235
Variables Selected Final Step (5)[a]	**$\underline{b}$ Weight**	**Constant (Intercept)**	**$\underline{B}$ Weight**
Pred. Score	.013		.398
Attit.-2	.014		.204
Perf. Time	.009		.151
Writ. Time	-.003		-.119
Age	-.016		-.111
		-1.12	

Regression Equation (Raw Score) $Y = .013X_4 + .014X_6 + .009X_8 - .003X_7 - .016X_1 - 1.12$

[a] Variables rearranged in rank order of their $\underline{B}$ weights.

b. Resume of Results

The preceding results identified and described eight pre/on-going training parameters relating to CBI, including their interrelationships between each other and four select training criteria. The four criteria were: achievement (written/performance), completion time, and pass/ fail incidence. The analysis consisted of the use of both simple (Pearson Product-Moment) and multiple (Wherry-Doolittle Test Selection) regression with each criterion. Noteworthy among the matrix of 66 simple correlations were those with the criteria. In rank order according to the size of their correlations were these predictor variables: predicted electronics score, electronics aptitude score, attitude-2 and attitude-1 scores. The predictor variable intercorrelations were uniformly low except for understandable relationships between the electronics aptitude score and predicted score (.79) due to the fact that latter is a weighted version of the former, and between the two attitude measures. Noteworthy among the four multiple regression analyses, which identified the unique predictors for each of the criteria considered separately, are the following findings given in rank order of their effectiveness: (a) Written Test I: maximum $\underline{R}$ = .725; minimum number of predictors derived was 4: predicted score, attitude-2, education, and attitude-1; (b) Time to Complete I: maximum $\underline{R}$ = .719; minimum number of predictors derived was 3: predicted score, attitude-2, and written (test) time; (c) Performance Test I: maximum $\underline{R}$ = .665; minimum number of predictors derived was 3: predicted score, attitude-1, and attitude-2; and, (d) Pass/Fail: maximum $\underline{R}$ = .507; minimum number of predictors was 4: predicted score, attitude-2, performance (test) time, written (test) time and age. Besides these valuable insights into the factors/relationships indigenous to CBI, the multiple regression analysis yielded an optimized regression equation for operational use to predict each of the four criteria respectively. Based on the least squares linear regression analysis used, optimal weights are assigned each selected predictor such that R^2 (criterion variance explained) is maximized with the least number of predictors for each criteria.

VIII GUIDELINES/RECOMMENDATIONS FOR OPTIMIZING CBI

The findings presented in the preceding Results and Analysis chapter addressed three broad issues on CBI: (a) replication of effectiveness ($CBI_{(1)}$ vs $CBI_{(2)}$); (b) replication of effectiveness (CBI vs CI); and, (c) factors/relationships unique to CBI. As stated in the outset of that chapter, and in accordance with overall project purposes, the ultimate focus of the data presented was to shape guidelines for optimizing CBI operationally and to provide recommendations for future exploration and research based on empirical experience with two CBI systems. This chapter will address these two areas with references to and inferences from the obtained data.

A. GUIDELINES FOR OPTIMIZING CBI: UTILIZATION

It is apparent that the number of areas to be addressed regarding optimization of CBI is potentially infinite. Indeed, it is beyond the scope of this report to focus on all possible aspects of CBI optimization. Therefore, the domain covered, and the degree to which any one area is considered. is necessarily delimited by: the course and student sampling, the study procedures employed, the issues and their subtopics addressed, and the dictates of the findings generated. Inferences and extrapolations are made, of course, as the logic of the findings and situation warrant.

The appropriate framework for categorizing comments in this section is properly based on the general structure underlying the preceding data analysis section. Thus, this covers the 2 generic areas of interest: (a) training effectiveness: student achievement (written/performance) and time to complete training (cf. Issue A); and, (b) training effectiveness: student attitude/opinions toward CBI (cf. Issue B). These are considered as very broad areas within which are conveniently classified and pivoted a number of subset categories including: hardware (on-/off-line); software; courseware; testware; ambient training-learning environment; and, staff/faculty impact. Spinoff from Issue C, factors and relationships of CBI cuts across both the other issues, and will therefore be treated jointly with them, not separately. It should be noted that the same source from which all study data was derived was the student. Since he is ultimately the prime consumer to be pleased and benefited, his performance, responses and reactions are the "acid test" to be met by a CBI system. From a larger perspective, the overall purpose of CBI is to optimize individualized training to achieve maximal end results (student achievement/performance) while minimizing training time and costs. It is to these individual and organizational objectives that the following guidelines and recommendations are directed. As much as possible the logic and terminology is formulated for generalization to education at large besides implication to the U.S. Army.

1. Training Effectiveness: Student Achievement/Performance

The results stemming from Issue A pertained to the replication of CBI as compared to CI across a number of investigations. The thrust of these initial CBI studies was, a fortiori, basically an inquiry regarding the feasibility and viability of two CBI systems: computer assisted instruction (CAI) and computer managed instruction (CMI) in teaching Army basic electronics fundamentals. Without any equivocation, the basic findings in the Army's initial CAI feasibility study, comparing CAI with CI, were replicated across several interim and a final summative evaluation. The findings were: that CAI students demonstrated equivalent or greater achievement, on average, than CI students and attained this in significantly less time. This result is impressive to training managers at large and particularly to Army cost conscious decision-makers. The dividends on an investment in CBI promises both cost benefits as well as cost effectiveness. Thus, extrapolating from the study results, one may expect that CBI students can achieve field productivity more quickly through a substantial reduction in training time, which is equated at the same time to greater cost savings for the service. Based on these replicated results, and the concensus from similar studies elsewhere, the following global guidelines (G) are empirically well based and contemporaneous within the present state of the art:

a. General

o G-1: CBI techniques (CAI/CDI/CMI) should be extended to all course material meeting the criteria established for CBI. Particularly, the advantages of CMI as the most cost effective way to bridge the gap between lock step and self-paced CBI are well documented. Use of CMI as prime, with CAI/CDI as supportive modes, appears indicated in the present state of the art.

OG-2: Increased study efforts ought now be directed toward improved development/implementation of CBI (i.e., $CBI_{(1)}$ vs $CBI_{(2)}$ vice CBI vs CI). Depending on any radical innovations of CBI as a whole, this emphasizes the need for more formative type evaluations in comparison to summative.

OG-3: Attempts at improving student achievement were only slightly successful while significant time savings were achieved. Traditionally, efforts in enhancing achievement have only been minimally fruitful or none at all. Given the current constraints of time and resources, expectation of success in converting traditional course material to CBI (regardless of CBI technique used) lies more in direct efforts in reduction of training time, with the proviso that it is accomplished without decrement to student achievement. Thus, student achievement should be used as a quality control measure with initial focus being given to cost effectiveness via reduction in time. Later efforts via formative evaluation can then focus on possible enhancement in achievement.

OG-4: In-house Army applications of CBI thus far have been restricted to conservative feasibility testing of student achievement, completion time and attitudes. Obtained findings cited herein warrant a more liberal approach to testing/applying other facets of CBI. These include: use of supportive CAI (enrichment tool etc.); imaginative applications of CMI (report generation for trainees, instructors and staff; resource allocation of personnel/media devices; testing/formative evaluation chores; test development/administration/item analysis/course diagnosis-prescriptions); and other interactive/batch processes of CBI. (Some of these are currently in developmental stage in Project ABACUS, Ft. Gordon, Georgia, an on-going Army effort in devising a computerized training system).

o G-5: While money/time are external limiting factors to a more rapid development, implementation, and proliferation of CBI, lack of advanced planning or ingenuity to mold CBI to one's needs is tantamount to self-imposed limitations. Thus, optimum utilization of CBI, a priori, presupposes early sound planning, not just in developing a given course segment/module but, more importantly, in the overall management of the CBI project's objectives. It's axiomatic: CBI is potentially a something for everyone proposition - but only if it is well planned and managed. It can't be turned loose and be expected to succeed; it must be closely managed, supervised, and "nursed".

b. Specific

Other selected guidelines relating to optimum utilization of CBI as derived from an analysis of Issues A/C considered jointly are presented below. Again, the focal point is training effectiveness of CBI as demonstrated by student achievement/performance.

o G-6: The single most noteworthy result of the CBI correlational analysis was the cross validation of the predicted electronics score variable. As the first predictor selected in the stepwise regression analysis for each of the four criteria it dominated the test battery selected to predict each criterion. This argues strongly for the use of "least squares" predicted scores for optimum utilization of CBI. This has not been utilized in-house to date. Multiple linear regression maximizes the prediction of a criterion ($\underline{R}^2$) by optimally weighting a set of predictors. Use of the Wherry-Doolittle Test Selection technique expediently selects the least number of variables yielding the highest multiple $\underline{R}^2$.

o G-7: Two specific areas which invite optimization are: (a) the CBI instructional model; and, (b) the staff faculty board which decides on go/no-go for students in difficulty. The instructional model consists of many decision points requiring a criterion "rule" for a determination of module go/no-go.

Statistically derived weights would establish optimized "rules" at certain critical points for more effective execution of the CBI instructional model. The staff faculty board is responsible for deciding the course go/no-go decision for high risk trainees. Juggling the many variables on a trainee would be greatly optimized and rendered more objective by means of statistically weighted scores.

o G-8: Another noteworthy result stemming from the correlational analysis was the contribution of unique variance to the prediction of all four training criteria by one or both of the attitude predictors, particularly the attitude 2 measure. This measure consisted of attitudes toward the CAI system/conditions. From the results, it is apparent that student attitude toward CBI is important toward predicting overall training effectiveness as measured by all crucial criteria. Therefore, due consideration to trainee attitudes must be given by a CBI manager if he is to attain optimum utilization of his CBI system.

o G-9: Across the conduct of several studies, it was readily apparent that the majority of trainees were favorably disposed toward CAI (i.e., on-line instruction). Those who were ill disposed toward on-line instruction tended to be the very lowest in aptitude. These, naturally, found excessive reading of text on a CRT to be difficult. Thus, to optimize training effectiveness for this student level, at least a two track instructional model is indicated where the low aptitude would be required (or permitted to choose) to take an array of off-line media under close tutorship of an instructor. The use of CAI for this group would be for support only (drill/practice). It is axiomatic: the high aptitude will succeed regardless of the methodology used; the lower aptitude levels, however, require all the "edge" they can get to succeed.

o G-10: Overall, it should be emphasized that just as the "heart" of the computer system is its software, so too the "heart" of a CBI system is its courseware and instructional model. Emphasis will be misplaced in CBI to stress equipment per se or software to the neglect of courseware and its strategies. Training effectiveness (student achievement) will suffer if course development is rushed and poorly validated, or if the strategies are inappropriate/inflexible to the trainee population. Thus, all elements of CBI must be addressed if its utilization is to be optimized.

2. Training Effectiveness: Student Attitudes/Opinions

The results derived on Issue B pertained to student attitudes/opinions toward CBI. This was the second generic area of interest in this project. In contrast with the 10 guidelines listed above, those delineated below address more operational topic areas tailored to promote optimum utilization of CBI. In general, as noted in the above guidelines, the overall finding stemming from the general-specific attitude results was that CBI was highly favored by students for training purposes. Further, in response to open ended questions, a number of substantive and constructive comments were elicited from the student samples. These were presented and discussed in detail in the preceding chapter. Based on these results, the following guidelines are presented according to topic areas of emphasis:

a. Physical Learning Conditions

oG-11: In comparing CBI with CI, the topic of physical learning conditions received much student attention. Both positive and negative aspects of CBI were addressed. Students are keenly sensitive to discomfort while learning under CBI, particularly during extensive use of on-line instruction (CAI). In order to counter negative attitudes to on-line instruction due to fatigue, allowance must be made for sufficient breaks away from the CRT.

oG-12: A specific area of discomfort receiving moderate attention was the physical size of the student carrel.

While most CBI students liked the carrel milieu in general, the confined size of the carrel was noted particularly by the peer-learning group. This is understandable because under this mode of instruction 2 students were delegated to a carrel originally designed for 1 student. It is noted here to emphasize the point that the design of carrels must take into consideration their potential future use. Peer-learning is highly likely to be used for certain types of course material. Flexible rather than fixed partitions may provide an answer. In some situations, only desk/table partitions or no partitions at all may be indicated.

b. Instructional Methodology

oG-13: Besides physical fatigue by extensive use of CAI, the matter of psychological boredom from constant use of one particular teaching method was noted also by some students. It behooves the designer of any variation of CBI to vary the instructional media sufficiently in order to optimize instructional effectiveness. It is immaterial whether these media are directly interfaced with the computer; rather, it is helpful that they be varied in conjunction with CAI. The availability of media options for student selection will, of course, be the ideal.

oG-14: Another area of student concern was the lack of flexibility to query the computer for information and repeat frames for review. Of course, with additional programming effort these capabilities are possible. Development of instructional programs should incorporate to some extent student control over the instructional process (i.e., ability to back up to review frames/material without repeating the entire lesson).

oG-15: The speed at which students are processed through CAI type training is of concern primarily to the lowest aptitude students. Typically, these are poor/slow readers. If alternate non-verbal media are not available allowance for this group must be made via more liberal frame time. The incessant "time outs" serve only as a constant reminder of failure for slow students. This group needs strong reinforcement not fear of constant failure. While this trades off time for achievement, it is preferred over pressuring low aptitude students. This approach, in fact, forms the basis for Bloom's mastery theory of learning (in Herrscher & Roueche, 1973) wherein, with time being allowed to vary, the expectation is that all students will eventually achieve mastery of behavioral objectives on criterion referenced tests.

c. Instructor Support

o G-16: It was never intended that CBI would replace the instructor. This myth still prevails and inhibits the expansion and acceptance of CBI. Only advanced and systematic public relations can dispel this wrong image of CBI. It is accepted that the instructor's role will change not be eliminated in CBI. He will be converted to a private tutor for those in need, leaving the burdens of teaching per se, record keeping, report generation (and other administrative tasks) to the CBI delivery and data processing system.

o G-17: Due to the changed role of instructors, the interpersonal/social relationship between student and instructor has also changed. CBI appears tobe more aware of the instructor's personal qualities. New expectations exist between the two. The relationship is far less adversarial and much more cooperative. The instructor is now accountable for individual students and not a "classroom" group. Thus, any lack of good instructor attitude will be more quickly sensed by students. Instructors should not be expected to make the quantum transition to CBI without undergoing a formal orientation on how to perform within CBI. The present "charm" school for conventional instructors should have its counterpart for CBI instructors. CBI can be a "dull" teacher and to be successful will require a new breed of dedicated and knowledgeable instructors.

d. Student Motivation/Performance

o G-18: The application of computers to training provided for the first time an opportunity for systematically applying a contingency management program of learning reinforcement. This would efficiently apply laboratory proven schedules of reinforcement in real-time operational training. As is known, besides ratio and interval type schedules, the intermittent reinforcement schedule is particularly most effective in shaping both motivation and performance. The present in-house CBI instructional models incorporate simple verbal reinforcements (good/great etc.) on a token basis. The proper use of known reinforcement schedules and other contingency principles would significantly improve the current instructional strategies.

e. CBI Equipment

o G-19: The image of a computer "crashing" and students waiting for hardware/software should be erased. Down-time is inevitable. Therefore, efficient back-ups must be planned, or the time savings accrued by CBI will evaporate. Instructor-managed training (computer printouts/PI booklets etc. provided to students) appears to be a viable alternative. Needless to say, where self-paced materials existed prior to the arrival of the computer a built in fall back system is ready to be called up with few adjustments.

o G-20: Some emphasis was given in comments received on the need for more equipment orientation prior to CBI. It cannot be assumed that many students have had CBI (most have not) or know how to type as required by keyboard entry. Adequate familiarity with the operation of all on-/off-line equipment is conducive to effective training. An orientation "course" with opportunity for drill/practice on the devices would be beneficial.

f. Peer/Individual-Learning

o G-21: Success with peer-learning (use of 2 students per carrel/terminal) as noted in this project strongly suggests its future use in CBI to be indicated. However, it cannot be expected that carrels designed for 1 student will accommodate 2. Further, it cannot be expected that instructional material designed for 1 student is directly convertible to 2 students without some adjustments and vice versa. Advanced planning to generalize instruction and strategies for an audience of 1 or more is indicated.

oG-22: A common area of agreement between the Peer/ Individual study groups was the value and need for graphics in learning. Use of verbal-text material alone is contraindicated for effective learning. The optimum amount of graphics necessary will vary, of course with subject matter. In this regard, the current innovations in computer generated graphics should be exploited fully.

B. RECOMMENDATIONS FOR OPTIMIZING CBI: RESEARCH

The above guidelines for optimizing CBI were immediate derivations from the data results of this project. Thus, by definition, their scope is necessarily delimited by the boundaries of the results and analysis. However, typically with any emergent innovation such as CBI, there remains a number of gaps in information relating to systems and procedures which require further assessment. In the interest of extending the data scope of this project to implications for follow-on CBI, the following recommendations for research and evaluation are proffered. These are heuristic considerations for future directions of CBI based on findings and experiences in this project. Similar to the guideline format above, the following recommendations (R) will be limited to statements of focal areas suggested for further development/exploration:

1. General

oR-1: That a "road map" be developed to chart the long range direction of CBI within the institution. The piecemeal approach used to date is subject to redundancy. This should be projected outward by 5-10 years. Included should be consideration of both regional (dial-up) as well as dedicated site specific uses of CBI; the use of mini-computer networks for institutional training applications as well as micro-processors for field/small unit training containing data tapes to be "dumped" on central processors; the use of optical scan vice keyboard entry; etc. Considering the broad needs for diverse applications of CBI a liberal attitude toward a variety of hardware configurations is more realistic. The "road map" should provide for an evolutionary growth of CBI from simple to more complex applications so that in-house expertise can keep up with the proliferation process.

o R-2: That both potential CBI courses and the three techniques of CBI (CAI/CDI /CMI) be evaluated and plotted jointly for optimum training/cost effectiveness. Rather than force courses to fit a given CBI configuration, courses should be evaluated to determine what CBI configuration would be most effective and cost effective for them. This decision, of course, would include what CBI "mix" would be optimum for for each course respectively.

o R-3: That a formal selection/training program be developed to standardize the identification and orientation of personnel. This will insure that good "drivers" will be assigned to the various levels of a CBI program: i. e., managers, developers, instructors and staff. If CBI is to succeed, it is imperative that it not only have a sound "road map" (5-10 year plan) and an adequate "vehicle" (appropriate hardware/software/courseware) but also the most proficient and dedicated "drivers" available. Conventional instructors should not be expected to make the transition automatically.

oR-4: That, subsequent to the required summative evaluation of major innovations to insure the total product meets certain minimum quality control standards and is cost effective, attention be focused on formative (process) evaluation of CBI. Initial research must be given to determine exactly what systems evaluation procedures/criteria one desires for his formative evaluation. Care must be given to reduce the number of data reports required to a bare minimum to avoid the "wallpaper" effect. One can be swamped with computer printouts for troubleshooting (diagnosing/prescribing) course material. The thrust here is to maintain/improve the quality of instruction with each succeeding iteration of student samples by means of computerized data reduction of student performance. A simple consolidated set of generated reports must be devised if it is to be used/accepted by staff personnel

o R-5: That initial CBI applications serve as "test beds" for further applied research. It is unrealistic to expect that all potential uses of CBI can be implemented on the first iteration of CBI. With highly compressed time phase plans and limited personnel resources the best one can expect is that one can get "a system" up and running with just a few basic components of CBI in an operational state. Other more sophisticated CBI processes should await maturation of the system and staff personnel. Trying to be too fancy initially runs the risk of sacrificing quality for quantity. It is a bad trade off. Instead, development of more advanced CBI subsystems as: formative evaluation routines (item analysis: difficulty, discrimination, validity); resource allocation (for student queueing, media/ equipment availability) etc., is ideally suited for "test bed" research/development. In this manner "a system" can be up and operational at the earliest possible time while more advance applications are "honed" to readiness and phased in at later stages.

o R-6: That the application of multiple linear regression analysis be explored both for improving the prediction of overall CBI performance/success as well as adding statistically weighted "rules" for improving decision making within the CBI instructional model. The "least squares" method of prediction offers an element of precision to expert opinion in matters of prediction.

o R-7: That the optimum student to instructor ratio be evaluated for various aptitude levels. Experience indicates that the high/middle aptitude can be self-supporting in self paced instruction for the most part; whereas, the low aptitude student disproportionately requires a greater amount of attention. Accordingly, seating arrangements, training schedules and other administrative/logistical factors may possibly be optimized, thus requiring fewer instructors to minister to greater numbers of students.

2. Specific

o R-8: That research/evaluation be conducted to optimize the following specific topic areas derived from an analysis of CBI student comments and experience resulting from several investigations on CBI:

- o The design of a flexible student carrel to accommodate more than one student (for peer instruction);

- o The optimum length of a CAI (on-line) session to avoid fatigue/boredom;

- o The degree to which media must be varied to preclude fatigue/boredom;

- o The capability of querying the computer on demand (in all variations of CBI) by the student for the purpose of: asking specific questions, repeating frames, reviewing selected material;

- o The varying of CAI frame time-out interval relative to aptitude level: i.e., giving more time to lower aptitude levels and increasingly less to upper levels;

- o The proper qualities (training/attitude/role etc.) of a CBI instructor given his new tutorial relationship with individual students;

- o The application of contingency management principles ($\underline{S}$-$\underline{R}$-$\underline{R}_f$; shaping behavior by approximations etc.) to enhance student motivation/performance via behavior modification;

- o The development of expedient/efficient back-up systems to down-time;

- o The judicious use of peer-learning to further enhance the cost effectiveness of CBI;

- o The expedient use of computer generated graphics to reduce the labor intensive efforts of current graphics development and further enhance the cost effectiveness of CBI. It should be exploited fully.

IX SIGNIFICANCE/IMPLICATIONS

The results of this project yielded evidence relating to strong empirical replication of the instructional effectiveness of computerized training. Such evidence is crucial in this infant stage in the global evaluation of the effectiveness of computerized training. Such verification argues strongly for computer-based education as an alternative educational technique, or adjunct tool, either as a valuable tutorial device (CAI) or as an excellent management aid (CMI). The high potential of CBI remains to be exploited more fully not only as a delivery system but also for its educational management uses.

More specifically, guidelines derived from the findings of this project were tailored to provide operational CBI personnel with a select set of empirically based "pro's and con's for optimizing the use of CBI as it applies to: instructional development; course operation; ambient learning conditions; student motivational factors; social factors in learning; and, a number of other crucial matters of interest to CBI course administrators, instructional staff and trainees. Secondly, a select set of heuristic recommendations derived from the findings of this project were delineated to point a direction for further required research and evaluation areas which may bring CBI to greater fruition. The generality of the findings of this applied research project are manifold and significant not just for Tri-Service training but across the entire gamut of civilian education as well. Given the solid positive results of this project, and similar findings coming in from elsewhere. it now remains for the current generation CBI systems under development to focus on "honing" CBI for maximum effectiveness, demonstrate cost effective applications, and gear up for proliferation.

X. GLOSSARY

In the conduct of this study the following definitions are used:

- ANOVA: analysis of variance.
- Author Language: is the language required for authoring instructional material.
- CAI: computer assisted instruction; on line instruction.
- CBI: computer-based instruction; a generic term used to define several applications of computerized training; i.e. CAI, CDI CMI.
- CBI (1): the IBM 1500 Instructional System. (special label).
- CBI (2): the PLATO IV Computer-based Educational System (special label).
- CDI: computer directed instruction; instruction is typically off line near the terminal with interactive input of results to the computer for guidance.
- CMI: computer managed instruction; instruction is typically off line away from the terminal.
- CPU: central processing unit of the computer.
- CRT: cathode ray tube; a television like display device.
- CTS: computerized training system; currently under prototype development in the Army.
- Down-time: computer not available for operational use due to malfunction.
- IC: instructor controlled training.

- I-L: individual-learning mode; in contrast to peer-learning.
- Interactive Terminal: a terminal permitting user interface with computer.
- Interface: a shared boundary between two subsystems.
- Light-pen: photo-sensitive device interfaced with the computer.
- Macro: an instruction that is replaced in a routine by a predetermined sequence of machine instructions.
- MOS: Military Occupational Specialty (e.g., 26420, 32020 etc).
- PI: programmed instruction method.
- Plasma Terminal: a display panel, which unlike the CRT, requires no regeneration of its signal.
- POI: plan of instruction; guide/requirements for teaching.
- S: stimulus.
- R: response.
- RF: reinforcement.
- Variables:
  - Age: # of years.
  - Educ: education (# of years).
  - Elec: electronics aptitude score (Cf. Army Basic Test Battery).
  - Pred: predicted score (multiple regression equation score).
  - Attit-1: attitude score (Part I: IBM 1500 questionnaire).
  - Attit-2: attitude score (Part II: IBM 1500 questionnaire).
  - W-time: written test time.

- P-time: performance test time.
- Writ: written test score (Phase I/II respectively).
- Perf: performance score (Phase I/II respectively).
- Time: completion time (Phase I/II respectively).
- Pass/Fail: success/failure (Phase I/II respectively).

XI BIBLIOGRAPHY

Aaronson, D. C. ICU/PLANIT: The all purpose machine transferable CAI system. Paper presented to the Institute of Technical and Industrial Communications, Colorado State University, Fort Collins, Colorado, July, 1971.

Alpert, D. and Bitzer, D. L. Advances in computer-based education science. 1970, CLXVII (3), 1588 - 89.

Anastasio, E. J. & Morgan, J. S. Factors inhibiting the use of computers in instruction. (Final Report: NSF - GJ - 27427) EDUCOM, Interuniversity Communications Council, Inc., 1972.

Arena, J. E. An instrument for individualizing instruction. In J. E. Duane (Ed.), Individualized instruction-programs and materials. New Jersey: Educational Technology Publications. 1973.

Barnes, O. D. A computer assisted instruction annotated bibliography. Phi Delta Kappa, Inc. September 1968.

Bitzer, D. and Skaperdas, D. The design of an economically viable large-scale computer-based education system. (CERL Report X-2). University of Illinois, Computer-based Education Resea..h Laboratory, September 1971.

Blake, H. E. & McPherson, A. W. Individualized instruction - where are we? In J. E. Duane (Ed.), Individualized instruction-programs and materials. New Jersey; Educational technology Publications, 1973.

Bloom, B. S. Learning for mastery. In J. E. Roueche & B. R. Herrscher (Eds.) Toward instructional accountability: A practical guide to educational change. Westinghouse Learning Press, 1973.

Campbell, D. T. Factors relevant to the validity of experiments in social settings. Psychological Bulletin, 1957, 54, 297-312.

Cardarelli, S. M. The LAP - a feasible vehicle of individualization. In J. E. Duane (Ed.), Individualized instruction-programs and materials. New Jersey; Educational technology Publications 1973.

Carnegie Commission on Higher Education. The fourth revolution, instructional technology in higher education: A report and recommendations. New York: McGraw Hill, 1972.

Cooley, W. W. and Glazer, R. The computer and individualized instruction. Science, 1966, 166, 574-582.

Edwards, A. L. *Statistical methods for the behavioral sciences.* New York; Rinehart & Company, 1954.

Evans, A. A. *An automated student registration procedure for IBM 1500 Instructional System (REGIS).* (CAI-TR-70-2). U. S. Army Signal Center and School, Fort Monmouth New Jersey, May, 1971.

Flanagan, J. C. The plan for individualizing education, *NCME*, 1971, *2* (2). 1-8.

Fletcher, J. D. *Models of the learner in computer-assisted instruction.* Paper presented at the American Psychological Association Meeting, New Orleans, La., August 1974.

Fry, E. B. *Teaching machines and programmed instruction: An introduction.* New York: McGraw Hill, 1963.

Frye, C. H. CAI languages: Capabilities and applications. *Datamation.* 1968, *14* (9(, 34-37.

Giunti, F. E. & Longo, A. A. *An interim evaluation of the tutorial mode of CAI in Army basic electronics training.* Paper presented at the Annual Convention of the N. E. Educational Research Association. Grossinger, N. Y. November, 1971.

Guilford, J. P. *Fundamental statistics in psychology and education.* (4th ed.). New York: McGraw Hill, 1965.

Hall, K. A. Computer assisted instruction: Problems and performance. *Phi Delta Kappan.* 1971, *10* (6), 628-631.

Hansen, D. N. Computer assistance with the educational process. *Review of Educational Research.* 1966, 36 (5), 588-603.

Harding, L. G. and Fleischman, H. L. *Aptitude level and consumer acceptance of programmed instruction.* (Research Memorandum SRM 68-9),

Hays, W. L. *Statistics for psychologists.* New York: Holt, Rinehart & Winston, 1963.

Herrscher, B. R. A systematic approach to instruction. In J. E. Roueche & B. R. Herrscher (Eds.), *Toward instructional accountability: A practical guide to educational change.* Westinghouse Learning Press, 1973.

Hoye, R. E. and Wang, A. C. *Index to computer-based learning.* Educational Technology Publications, Englewood Cliffs, New Jersey, 1974.

Hurlock, J. A. & Hurlock, R. E. Comparison of paired students and individual students trained by CAI. (Research Report SRR 73-21). Naval Personnel and Training Research Laboratory, June 1973.

IBM Corporation and USCONARC. A feasibility of computer assisted instruction in U.S. Army Basic Electronics training. (Final Report. Contract No. DAAB07-67-C-0578). Gaithersburg, Maryland, February, 1968.

Jamison, D., Suppes, P. & Wells, S. Effectiveness of alternative instructional media. Review of Educational Research, 1974, 44. 1-67.

Kimberlin, D. A. Instructional programming guide for computer assisted instruction. (CAI-TR-71-3), U.S. Army Signal Center and School, Fort Monmouth, New Jersey, July, 1971.

King, A. T. Impact of computer-based instruction on attitudes of students and instructors: a review Brooks Air Force Base, Tex.: Air Force Human Resources Laboratory Air Force Systems Command, May 1975.

Longo, A. A. The implementation of computer assisted instruction in the U.S. Army basic electronics training: Follow-up of a feasibility study. (CAI-TR-69-1). U.S. Army Signal Center and School, Fort Monmouth, New Jersey, September, 1969.

Longo, A. A. A summative evaluation of computer assisted instruction in U.S. Army basic electronics training. (CAI-TR-72-1). U.S. Army Signal Center and School, Fort Monmouth, New Jersey, May 1972. (a)

Longo, A. A. A sequential evaluation of computer assisted instruction in U.S. Army basic electronics training. Paper delivered at the Annual Convention for the Development of Instructional Systems. Ecole Normale Notre Dame de Foy, Cap Rough Campus, Quebec, Canada, August, 1972. (b)

Longo, A. A. & Lamb, J. M. Instructional effectiveness of the PLATO IV plasma terminal. (CTS-TR-75-2). U.S. Army Signal Center and School, Fort Monmouth New Jersey, May, 1975.

McNeman Q. Psychological statistics. (4th ed.). New York: Chapman & Hall, LTD. 1949.

Mitzel, H. E. & Wodtke, K. H. Development and presentation of four different college courses by computer teleprocessing.(Report R-1). CAI Laboratory, Penn State University, 1965.

Merrill, M.D., & Boutwell, R.C. Instructional development: Methodology and research. In F.N. Kerlinger (Ed.), Review of Research in Education. Itasca, Ill: F.E. Peacock, 1973.

Middleton, M.G., Papetti, C.J. & Micheli G.S. Computer managed instruction in Navy Training (TAEG Report 14). Orlando, Fla: Naval Training Equipment Center, Training Analysis and Evaluation Group, March 1974.

Mizenko, A.J. and Evans, A.A. An instructional model for computer assisted instruction. (CAI-TR-70-3). U.S. Army Signal Center and School, Fort Monmouth, New Jersey, May, 1970.

Molnar, A.R. Computer innovations in education. National Science Foundation Report, January 1972.

Performance testing for systems engineered courses. Evaluation Division, Office of Director of Instruction: U.S. Army Signal Center and School, Fort Monmouth, New Jersey, 1971.

Pressey, S.L. A simple apparatus which gives tests and scores - and teaches. School and Society. 1926, 23 (3), 373-376.

Razik, T.A. Bibliography of programmed instruction and computer assisted instruction. Vol. I. The Education Technology Bibliography Series. Englewood Cliffs, New Jersey, 1971.

Rich, J.J. & Van Pelt, K:B. Survey of computer applications in Army training (CTS-TR-74-3). Ft. Monmouth: U.S. Army Communication Electronics School, Office of the Product Manager, Computerized Training System, August, 1974.

Rockway, M.R. & Yasutuke, J.Y. The evaluation of the Air Force advanced instructional system. Journal of Educational Technology Systems, 1974, 2 217-239.

Schure, A. Educational escalation through systems analysis: Project ULTRA at New York Institute of Technology. Audiovisual Instruction. May, 1965.

Schure, A. An accountability and evaluation design for occupational education. Educational Technology. 1971, XI (3), 26-37.

Secretary of Defense to Department Secretaries. Letter, subject: Innovation in defense training and education. June, 1965.

Seidel, R. J., Hunter, B., Kastner C. & Rubin, M. Obstacles to widespread use of computer-based curricular innovations: A Review. Journal of Computer-based Instruction. 1, 28, 1974.

Siegel, S. Nonparametric statistics for the behavioral sciences. New York: McGraw Hill, 1956.

Silvern, L. C. Programmed instruction and computer-assisted instruction: How they can be used effectively in our training programs. Paper presented at the National Aeronautic Meeting and 3rd International Simulation and Training Conference, April, 1967.

Silvern, L. C. Training educational administrative in anasynthesis. Educational Technology. 1972. XII (2), 8-17.

Skinner, B. F. Teaching machines. Science, 1958, 128 (10), 969-977.

Snedecor, G. W. Statistical methods. Ames, Iowa: Iowa State College Press, 1946.

Suppes, P. On using computers to individualize instruction. In D. Bushnell. & W. C. Allen (Eds.), The computer in American Education. New York: Wiley, 1967.

TRADOC Regulation. Systems engineering of training: Course design. April, 1972.

USASCS. A macro system for computer assisted instruction. CAI-TR-70-3. U. S. Army Signal Center and School. Fort Monmouth, New Jersey, May, 1970.

USASCS. Applications of computers to training. (CAI-TR-71-1). U. S. Army Signal Center and School, Fort Monmouth, New Jersey, Apr. 1971.

USCONARC. Long range ADPS master plan (Schools). Headquarters, U. S. Continental Army Command. December, 1968.

USCONARC. Task group report: Computer assisted instruction. Chaired by U. S. Army Signal Center and School, Fort Monmouth, New Jersey, April, 1972.

Walker, G. S. and Gardner, E. M. Application of computers in educational and training systems: A survey of computer-assisted instructional centers. (AFHRL-TR-70-24) Air Force Human Resources Laboratory, Brooks Air Force Base, Texas, December, 1970.

Zinn, K. L. Requirements for programming in computer-based instructional systems. Educational Yearbook, 1971-1972.

Appendices A-D

Achievement testing for Phases I/II of basic electronics fundamentals is represented by both written/performance tests contained in appendices A-D. Appendices A and C are samples of the actual written/performance tests for Phase I; Appendices B and D are the instructional topic areas covered by the respective parallel tests for Phase II.

A

PHASE I WRITTEN TEST

DO NOT MARK THIS BOOKLET

DIRECTIONS

1. Each of the following questions or incomplete statements is followed by four (4) possible answers only one (1) of which is correct or clearly the best. Indicate your answer using an ADP pencil and by making a heavy black mark in the oval containing the proper letter on the answer card.

2. Check the number of the item on the ADP answer card against the item number in the test booklet to insure the numbers correspond. Misplaced answers will be scored as wrong answers.

3. Do not cross out a misplaced answer. Erase it completely. The machine will score partially erased answers as wrong answers. Two or more responses for a single item will cause the machine to score the item wrong.

DO NOT MARK THIS BOOKLET

1. The value of the resistor shown is

A. 470 ohms, 10% tolerance
B. 470 ohms, 5% tolerance
C. 47 ohms, 10% tolerance
D. 47 ohms, 5% tolerance

2. To reduce the possibility of equipment failure during operation, the repairman should

A. familiarize himself with the specific defects of the equipment
B. maintain the equipment after a breakdown to prevent stoppage
C. prevent breakdown by the location and repair of defects
D. perform preventive maintenance

3. The quantity 5.30K ohms can be expressed as

A. 0.0053 ohm
B. 530 ohms
C. 5,300 ohms
D. 530,000 ohms

4. A shorted resistor in a series circuit containing three equal resistors results in an increased

A. applied voltage
B. total current
C. total resistance
D. value of the two remaining resistors

5. In the circuit shown, an open fuse would be caused by

A. a shorted lamp L2
B. a shorted resistor R1
C. an open lamp L2
D. an open lamp L1

6. When checking circuit voltages with a voltmeter, a precaution the repairman should observe is to

   A. use the highest range of the voltmeter first
   B. use the lowest range of the voltmeter first
   C. make certain the circuit power is off
   D. connect the meter on series with the circuit

7. A changing current in a coil causes what action?

   A. Self induction
   B. Steady counter emf
   C. Steady magnetic field
   D. Pure direct current to flow

8. Three 24 ohm resistors, connected in parallel, will have a total resistance of

   A. 6 ohms
   B. 8 ohms
   C. 24 ohms
   D. 72 ohms

9. During the positive alternation of a frequency cycle, the maximum voltage developed is the

   A. effective voltage
   B. rms voltage
   C. peak voltage
   D. peak-to-peak voltage

10. In the circuit below, which switch should be closed to light the lamp?

   A. Switch A
   B. Switch B
   C. Switch C
   D. Switch D

11. The ability of a material to conduct magnetic lines of force is termed
.

A. relativity
B. conductivity
C. retentivity
D. permeability

12. When all the lamps are of equal resistance, how does their brightness compare in the circuit shown?

A. Lamp A will be brighter than lamp B
B. Lamp A will be as bright as lamp B
C. Lamp B will be brighter than lamp C
D. Lamp A will be as bright as lamp C

13. To measure the current flow through resistor R1, a repairman should connect an ammeter between points

A. A-E
B. B-C
C. D-B
D. E-D

14. What effect is produced when a soft iron core is removed from an electromagnetic coil?

A. Magnetic field and conductance increase
B. Magnetic field and conductance decrease
C. Magnetic field increases and conductance decreases
D. Magnetic field decreases and conductance increases

15. The amount of power consumed by a 10 ohm resistor with a current of 2 amperes flowing through it is

A. 5 watts
B. 20 watts
C. 40 watts
D. 200 watts

16. If resistor R 2 opens, the brilliance of the light bulb will

A. increase
B. remain unchanged
C. decrease
D. fall to zero

17. When cutting heavy gauge wire a repairman should use

A. long-nosed pliers
B. diagonal pliers
C. side-cutting pliers
D. dykes

18. To prevent the indicating needle of the voltmeter from moving in the wrong direction when measuring d-c voltage, a repairman should

A. start with the highest meter range available
B. remove the circuit power before making the measurement
C. observe the correct polarity with the meter
D. start with high range, then go to a lower range

19. The quantity 0.03 ampere may be expressed as

A. 0.00003 milliampere
B. 0.0003 milliampere
C. 3.0 milliampere
D. 30.0 milliampere

20. Which resistor in the circuit shown will have the greatest amount of current flow?

A. R_1
B. R_2
C. R_3
D. R_4

21. What type of reading on an ohmeter would indicate an open resistor?

A. Infinite
B. Infinite, then gradually decreasing to zero
C. Infinite, then gradually decreasing to midscale
D. Zero

22. The total applied voltage in the circuit shown is

A. 25 volts
B. 30 volts
C 40 volts
D 70 volts

23. When working with high voltage electronic equipment, which procedure is NOT a safety precaution?

A. Approaching high voltage with back of the hand
B. Grounding repair personnel to the equipment
C. Removing rings and identification tags
D. Keeping one hand in a pocket

24. To dissipate 200 watts, the resistance of the bulb "A" when switch is opened, should be

A. 2 ohms
B. 100 ohms
C. 200 ohms
D. 400 ohms

B

Phase II: Written Test
(Lesson Topic Summary)[a]

Week 3 Lessons	Week 4 Lessons
L-1. VTVM TS-505D/U	L-1. Filament Circuits
L-2. Audio Frequency Gen.	L-2. Diodes
L-3. Inductance Reactance	L-3. Rectification
L-4. Capacitance Char.	L-4. Filters
L-5. Computing Capacitance Val.	L-5. Triodes
L-6. Capacitance Reactance	L-6. Voltage Ampl.
L-7. Impedance	L-7. Methods of Bias
L-8. Resonance	L-8. Classes of Ampl.
L-9. Filters	L-9. Tetrodes
L-10. Impedance Bridge	L-10. AF Power Ampl.
L-11. Transformers	L-11. Dir. & RC Coupl.
	L-12. Transfer Coupl.
	L-13. Tube Tester

[a]Some MOS's = week 3 only/Other MOS's = both week 3/4.

C

PHASE I PERFORMANCE TEST

DO NOT MARK THIS BOOKLET

DIRECTIONS

1. Each of the following questions or incomplete statements is followed by four (4) possible answers, only one (1) of which is correct or clearly the best. Indicate your answer using an ADP pencil and by making a heavy black mark in the oval containing the proper letter on the answer card.

2. Check the number of the item on the ADP answer card against the item number in the test booklet to insure the numbers correspond. Misplaced answers will be scored as wrong answers.

3. Do not cross out a misplaced answer. Erase it completely. The machine will score partially erased answers as wrong answers. Two or more responses for a single item will cause the machine to score the item wrong.

DO NOT MARK THIS BOOKLET

INTRODUCTION

1. You are going to take a performance test on identifying resistor values and circuit arrangements. Using the multimeter, you will measure resistance, voltage, and current.

2. The entire test will consist of four problems. You have already completed the soldering problem (Problem IV). Your total score will be the sum of the four problems which will then be converted into Army Standard Scores.

3. You will be graded on your performance. Perform each task according to classroom instructions you have received.

4. All required equipment will be available at the test positions. This includes a circuit board, multimeter, and leads, student diagram and work sheet, ADP card and pencil.

5. If during the test you are not sure of what to do next, ask your administrator for assistance. Technical assistance will not be given to you in solving a step.

6. You may refer any question to the Test Administrator after you have completed the test.

7. Do not give any information concerning this test to another student. It will cause your Army Standard Score to be lowered.

8. Ample time (approximately 20 minutes) has been allotted for each problem. You should be able to complete all your problems in 60 minutes, if you work at a steady pace.

PROCEDURE

A. DO NOT MARK THIS BOOKLET. It is only for your guidance in recording your answers on the ADP card.

B. Your examination will be performed with the circuit board, multimeter, and STUDENT DIAGRAM and WORK SHEET in front of you. The circuit board has been specifically wired for this examination and its test points and resistors are clearly identified; the symbols X and Y on the circuit board are used for test points and are independent of circuit polarities. Reconnect any wire you disconnect during the examination.

C. At the administrator's signal, turn to the next page and fill in your answers on your ADP card.

PROBLEM I

1. Use the resistor color code. What is the value of resistor R8?

   A. 1000K ohms
   B. 102 ohms
   C. 1K ohms
   D. .01 ohms

2. If all the other resistors were placed with a wire, in what circuit arrangement (if any) are resistors R6 and R8?

   A. Parallel
   B. Series
   C. Incomplete circuit
   D. Short circuit

3. Use the resistor color code. What is the value of resistor R9?

   A. .15 ohms
   B. 153K ohms
   C. .015 ohms
   D. 1500 ohms

4. If all the other resistors were placed with a wire, in what circuit arrangement (if any) are resistors R2 and R10?

   A. Incomplete circuit
   B. Parallel
   C. Series
   D. Short Circuit

5. Use the circuit analysis you made in STEPS 2 and 4. In what total combined circuit arrangement (if any) are resistors R6, R8, R2. and R 10?

   A. Series-parallel
   B. Series
   C. Parallel
   D. Incomplete circuit

6. Identify the test points at which the multimeter leads must be placed to measure the total resistance of resistors R6. R8. R2. and R10.

   A. Y8 - Y2
   B. Y8 - X8
   C. Y10 - X2
   D. Y2 - X10

7. SAFETY NOTE: BEFORE starting this step, insure that your resistor circuit board is NOT plugged in to your power source.

   Use the test points you have just selected in STEP 6. What resistance reading is obtained with your multimeter?

   A. 0 - .01M ohms
   B. 20K - 30K ohms
   C. 40K - 45K ohms
   D. .3M - .5M ohms

8. Identify the test points at which the multimeter leads must be placed to measure the total resistance of resistors R2 and R4.

   A. Y3 - Y2
   B. X2 - Y4
   C. Y2 - X4
   D. X8 - Y2

9. Use the test points you have just selected in STEP 8. What resistance reading is obtained with your multimeter?

   A. 2.2K - 4K ohms
   B. 0 - 500 ohms
   C. 25K - 30K ohms
   D. 600 - 2000 ohms

PROBLEM II

10. Use the resistor color code. What is the value of resistor R4?

    A. .015M ohms
    B. .15K ohms
    C. 1500 ohms
    D. 151 ohms

11. If all the other resistors were replaced with a wire, in what circuit arrangement (if any) are resistors R1 and R4?

    A. Short Circuit
    B. Series
    C. Incomplete circuit
    D. Parallel

12. Use the resistor color code. What is the value of resistor R1?

    A. 2.7K ohms
    B. .27K ohms
    C. .027M ohms
    D. 2700 ohms

13. If all the other resistors were replaced with a wire, in what circuit arrangement (if any) are resistors R6 and R10?

    A. Series
    B. Parallel
    C. Incomplete circuit
    D. Short circuit

14. Use the circuit analysis you made in STEPS 11 and 13. In what total combined circuit arrangement (if any) are resistors R1, R4, R6, and R10?

    A. Incomplete circuit
    B. Series
    C. Series-parallel
    D. Parallel

15. Identify the test points at which the multimeter leads must be placed to measure the total resistance of resistors R4 and R5?

    A. Y2 - X5
    B. Y5 - X4
    C. X2 - Y5
    D. X8 - X5

16. Use the test points you have just selected in STEP 15. What actual resistance reading is obtained with your multimeter?

    A. .2K - .6K ohms
    B. 2K - 6K ohms
    C. .02M - .06M ohms
    D. .2M - .6M ohms

17. Identify the test points at which the multimeter leads must be placed to measure the total resistance of resistors R4, R6, R8, and R10.

    A. Y9 - X10
    B. Y10 - Y4
    C. X4 - Y10
    D. X9 - Y10

18. Use the test points you have just selected in STEP 17. What actual resistance reading is obtained with your multimeter?

    A. .1K - .2K ohms
    B. .02M - .025M ohms
    C. .01M - .018M ohms
    D. .21K - .27K ohms

D

Phase II: Performance Test
(Lesson Topic Summary)

Week 3 Practical Exercises	Week 4 Practical Exercises
L[a]-3. Inductance Reactance	L-4. Power Supply
L -7. Impedance	L-6. Triodes/Voltage Ampl.
L -8. Series Resonance	L-8. Bias/Class. of Ampl.
L -9. Filters	L-12. Power Ampl/Coupl.
L-11. Transformers	L-13. Voltage Resistance Oper. Cks.

[a]L= Lesson.

Appendices E-F

Attitude testing for the IBM ($CBI_{(1)}$) and PLATO ($CBI_{(2)}$) study groups is represented by two questionnaires contained in Appendices E and F, respectively. Each questionnaire consists of two parts.

E

IBM SYSTEM QUESTIONNAIRE

DIRECTIONS

This is not an information test. Therefore, it has no right or wrong answers. Rather, we are interested in your frank opinion of the following statements. The results will be used to find new ways to improve electronics training at the Signal School.

PART I

In this part of the questionnaire you are asked to compare computer assisted instruction (CAI) with conventional instruction (CI), familiar to you as the instructor/text type of training which you had in high school, on 11 areas of general interest.

Please answer by circling the letter next to that alternative which best expresses your opinion on each of the following 11 statements.

PLEASE REMEMBER

CI = Conventional Instruction

CAI = Computer Assisted Instruction

1. I can learn new material

    a. much better with CI (Conventional Instruction)
    b. somewhat better with CI
    c. about the same with CAI or CI
    d. somewhat better with CAI (Computer Assisted Instruction)
    e. much better with CAI

2. I can retain new material (i.e., forget less)

    a. much better with CI
    b. somewhat better with CI
    c. about the same with CAI or CI
    d. somewhat better with CAI
    e. much better with CAI

3. I think instruction can be tailored to suit my training needs

    a. much better with CI
    b. somewhat better with CI
    c. about the same with CAI or CI
    d. somewhat better with CAI
    e. much better with CAI

4. When classroom difficulties arise, I am assisted

   a. much better under CI
   b. somewhat better under CI
   c. about the same under CAI or CI
   d. somewhat better under CAI
   e. much better under CAI

5. The sequence of instructional material is

   a. much better in CI
   b. somewhat better in CI
   c. about the same in CAI and CI
   d. somewhat better in CAI
   e. much better in CAI

6. My attention is kept

   a. much better in CI
   b. somewhat better in CI
   c. about the same in CAI or CI
   d. somewhat better in CAI
   e. much better in CAI

7. The learning atmosphere is

   a. much better in CI
   b. somewhat better in CI
   c. about the same in CAI or CI
   d. somewhat better in CAI
   e. much better in CAI

8. My training time is used

   a. much better with CI
   b. somewhat better with CI
   c. about the same with CAI or CI
   d. somewhat better with CAI
   e. much better with CAI

9. My interest to learn electronics can be stimulated

   a. much better with CI
   b. somewhat better with CI
   c. about the same with CAI or CI
   d. somewhat better with CAI
   e. much better with CAI

10. I get tired of training

  a. much faster in CI
  b. somewhat faster in CI
  c. about the same in CAI or CI
  d. somewhat faster in CAI
  e. much faster in CAI

11. Overall, my opinion is that

  a. CI is much better than CAI
  b. CI is somewhat better than CAI
  c. Both are about the same
  d. CAI is somewhat better than CI
  e. CAI is much better than CI

PART II

In this part, you are asked to express your opinion on statements relating only to CAI. Circle the letter next to the alternative that best expresses your opinion. Additional space is provided for any cpmments you desire to make. Please be as specific as possible in identifying the part of the CAI material to which your comments refer (i.e., week of instruction, lesson topic, etc.) The Student Check List is recommended as an aid in specifying the CAI material.

1. Sequence of the CAI material

  a. very good
  b. good
  c. neutral
  d. poor
  e. very poor

Comment:

2. Level of reading skill required by the CAI material

  a. very low
  b. low
  c. neutral
  d. high
  e. very high

Comment:

3. Style of the CAI material

  a. very informal
  b. informal

c. neutral
d. formal
e. very formal

Comment:

(WHERE POSSIBLE, SPECIFY LESSON TOPIC(S) IN YOUR COMMENTS)

4. Physical comfort of the CAI carrel (seating, height of instructional display and image projector, work area, lighting, etc.)

   a. very good
   b. good
   c. neutral
   d. poor
   e. very poor

Specify: (type of discomfort/when etc.)

5. Amount of fatigue caused by CAI

   a. none
   b. very little
   c. neutral
   d. some
   e. a lot

Specify: (type of fatigue/when etc.)

6. Helpfulness of the image projector slides

   a. a lot
   b. some
   c. neutral
   d. very little
   e. none

Comment:

(WHERE POSSIBLE, SPECIFY LESSON TOPIC(S) IN YOUR COMMENTS)

7. Number of frames presented in the CAI lessons

   a. very satisfactory
   b. satisfactory
   c. neutral
   d. unsatisfactory
   e. very unsatisfactory

Specify: (lesson topic(s) with too many/too few frames)

8. Amount of material presented in the CAI frames

   a. very satisfactory
   b. satisfactory
   c. neutral
   d. unsatisfactory
   e. very unsatisfactory

Specify: (lesson topic(s) having frames with too much/too little material)

9. Background noise in the room interferred with learning

   a. never
   b. occasionally
   c. neutral
   d. much of the time
   e. all of the time

Comment:

WHERE POSSIBLE, SPECIFY LESSON TOPIC(S) IN YOUR COMMENTS)

10. Operating noises of the image projector interferred with learning

a. never
b. occasionally
c. neutral
d. much of the time
e. all of the time

Comment:

11. Did CAI tend to bore you?

a. no
b. yes

Comment:

12. Briefly compare CAI with CI.

13. What did you like about CAI?

14. What did you dislike about CAI?

F

PLATO SYSTEM QUESTIONNAIRE

DIRECTIONS

This is not an information test. Therefore it has no right or wrong answers. Rather we are interested in your frank opinion of the following statements. The results will be used to find new ways to improve future training by the computer.

PART I

In this part of the questionnaire you are asked to give your opinion about the 3 different ways the computer was used for instruction. Circle the letter next to the alternative that best expresses your opinion. Additional space is provided for any comments you desire to make. Please be as specific as possible in identifying the part of the lesson material to which your comments refer.

A. Questions 1-4 relate to your reactions toward instruction presented on the PLATO terminal in the DC fundamental lessons.

1. Helpfulness of drawings or graphics on the computer terminal was

   a. a lot
   b. some
   c. neutral
   d. very little
   e. none

Comments:

2. Number of frames (computer terminal pages) in the lessons presented only on the computer terminal was

   a. very satisfactory
   b. satisfactory
   c. neutral
   d. unsatisfactory
   e. very unsatisfactory

Specify: lessons with too many/too few frames.

3. Amount of material presented in the frames on the computer terminal was

   a. very satisfactory
   b. satisfactory
   c. neutral

d. unsatisfactory
e. very unsatisfactory

Specify: (lesson having frames with too much/too little material)

4. Sequence of the lesson material presented on the computer terminal was

a. very good
b. good
c. neutral
d. poor
e. very poor

Comments:

B. Questions 5-8 relate to your reaction toward the lessons on SAEDA and First Aid & Safety

5. When proceeding through the lessons on SAEDA and First Aid & Safety, the coordination between the tv cassette player and the computer questions was

a. very good
b. good
c. neutral
d. poor
e. very poor

Comments:

6. Distraction caused by going to tv cassette player for instruction and back to the computer for testing was

a. none
b. very little
c. neutral
d. some
e. a lot

Comments:

7. Would it have been helpful to have stopped the tv cassette player at certain segments throughout the lesson for questions on the computer before proceeding?

a. very much
b. some
c. neutral

d. very little
e. not at all

Comments:

8. The length of the lessons were

a. very satisfactory
b. satisfactory
c. neutral
d. unsatisfactory
e. very unsatisfactory

Specify: (lessons, too long, too short)

C. Question 9-13 relate to your reactions toward the lesson on Troubleshooting Procedures.

9. When taking the lesson on Troubleshooting Procedures, the coordination between the sound on slide projector instruction and the computer questions was

a. very good
b. good
c. neutral
d. poor
e. very poor

Comments:

10. Do you feel that typing in the slide label was needed to coordinate the projector instruction with the computer questions?

a. not at all
b. very little
c. neutral
d. some
e. a lot

Comments:

11. Distraction caused by going to the sound on slide projector for instruction and back to the computer for testing was

a. none
b. very little
c. neutral
d. some
e. a lot

12. Would it have been helpful to have completed the lesson on the sound on slide projector and then had all the questions at one time?

a. not at all
b. very little
c. neutral
d. some
e. a lot

Comments:

13. The length of the lesson was

a. very satisfactory
b. satisfactory
c. neutral
d. unsatisfactory
e. very unsatisfactory

Specify: (too long, too short)

14. Compare the type of instruction you received in the Troubleshooting Procedures lesson with the type of instruction you received in the SAEDA and First Aid & Safety lessons. Your opinion of the teaching approaches is that

a. all questions at the end of a lesson are much better
b. all questions at the end of a lesson are somewhat better
c. both are about the same
d. questions throughout the lesson are somewhat better
e. questions throughout the lesson are much better

PART II

In this part of the questionnaire you are asked to give your opinion of the PLATO terminal, sound on slide projector, tv cassette player and your work area. Circle the letter next to the alternative that best expresses your opinion. Additional space is provided for any comments you desire to make.

A. Questions 1-6 relate to your reaction toward the computer terminal

1. Difficulty using the computer terminal for instruction was

a. none
b. very little
c. neutral
d. some
e. a lot

Specify: (problem you had using terminal)

2. Disregarding unfamiliarity with the keyboard, operation of the keyboard was

a. very difficult
b. difficult
c. neutral
d. relatively easy
e easy

Specify: (problems)

3. Distraction caused by the time delay of lesson material coming on the screen was

a. none
b. very little
c. neutral
d. some
e. a lot

Comments:

4. The images on the PLATO screen are

a. very clear
b. clear
c. neutral
d. some distortion
e. very distorted

Comments:

5. Eyestrain caused by the terminal screen was

a. none
b. very little
c. neutral
d. some
e. a lot

Comments:

6. Size of the letters on the terminal screen was

a. very satisfactory
b. satisfactory
c. neutral

d. unsatisfactory
e. very unsatisfactory

Specify: (too small, too large, etc.)

B. Question 7-8 relate to your operation of the training devices used other than the computer terminal.

7. Operation of the tv cassette player was

a. easy
b. relatively easy
c. neutral
d. difficult
e. very difficult

Specify: (setting controls, loading, proceeding through)

8. Operation of the sound on slide projector was

a. easy
b. relatively easy
c. neutral
d. difficult
e. very difficult

Specify: (setting controls, loading, proceeding through)

C. Question 9-11 relate to your opinion of your work area and surroundings

9. Amount of space in the carrels (working area) was

a. very satisfactory
b. satisfactory
c. neutral
d. unsatisfactory
e. very unsatisfactory

Comments: (too small, too large etc.)

10. Arrangement of teaching devices in the carrels was

a. very good
b. good
c. neutral
d. poor
e. very good

Specify: (cluttered, convenience of placement of terminal, sound on slide or tv cassette player, etc.)

11. Lighting at the carrels are

   a. very good
   b. good
   c. neutral
   d. poor
   e. very poor

Comments:

D. Question 12 and 13 relate to other factors which might affect learning

12. Background noise in the room interfered with learning

   a. none
   b. occasionally
   c. neutral
   d. much of the time
   e. all of the time

Specify: (equipment noise of tv player, s/s recorder, or terminal; voices, outside, etc.)

13. Amout of fatigue caused by computer training was

   a. none
   b. very little
   c. neutral
   d. some
   e. a lot

Specify: (type of fatigue? when, etc.)

14. Express your feeling toward a computer teaching system over much longer period of time (attention, learning, fatigue etc.)

Appendices G-H

Summary of the pretest and post test data for the IBM feasibility study ($CBI_{(1)}$) is contained in Tables 33 and 34.

G

Table 33

Summary of Pretest Data

Method	M	SD.	Aptitude Level	M	SD
TV	32.40	12.80	High	49.10	10.30
IC	33.90	14.80	Med	30.00	10.20
CAI	37.00	14.10	Low	24.30	4.90
Total	34.50	13.80			

H

Table 34

Summary of Post Test Data

Method	M	SD	Aptitude Level	M	SD
TV	57.40	15.20	High	74.20	3.00
IC	55.70	18.90	Med	58.30	8.80
CAI	60.20	14.40	Low	40.78	11.30
Total	57.80	16.10			

Appendix I

The complete stepwise regression analyses for Phase I.

(Tables 35 - 49)

Table 35

Stepwise Regression Analysis: I
Criterion: Written Test I
(Step 1)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	9
Residual Variance	117.714	Predictor Entered	4
Residual S.D.	10.850		
Std. Error of Mean	.920		
Multiple R	.630		
Multiple R^2	.397		
Shrunken $\bar{R}^2$	.397		
Constant (Intercept)	-8.800		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Pred. Score (4)	.840	.088	.630	.066

Analysis of Variance

Source	SS	df	MS	F
Regression	10613.09	1	1063.09	90.16
Error	16126.82	137	117.71	

Table 36

Stepwise Regression Analysis: I
Criterion: Written Test I
(Step 2)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	9
Residual Variance	100.583	Predictor Entered	6
Residual S. D.	10.029		
Std. Error of Mean	.851		
Multiple R	.699		
Multiple R^2	.488		
Shrunken $\bar{R}^2$	.485		
Constant (Intercept)	-43.02		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Attit-2 (6)	.866	.176	.304	.062
2. Pred. (4)	.795	.082	.597	.062

Analysis of Variance

Source	SS	df	MS	F
Regression	13060.45	2	6530.224	64.924
Error	13679.29	136	100.583	

Table 37

Stepwise Regression Analysis: I
Criterion: Written Test I
(Step 3)

Regression Factors	Statistics	Selected Measures	Variable
(Sample $\underline{N}$)	(139)	Criterion Used	9
Residual Variance	95.676	Predictor Entered	2
Residual $\underline{S.D.}$	9.781		
Std. Error of Mean	.830		
Multiple $\underline{R}$	.719		
Multiple $\underline{R}^2$	.517		
Shrunken $\bar{R}^2$	.510		
Constant (Intercept)	-59.89		

Variable(s) Selected	$\underline{b}$ Coef	$\underline{b}$ Std. Error	$\underline{B}$ Coef	$\underline{B}$ Std. Error
1. Attit-2 (6)	.925	.173	.325	.061
2. Pred. (4)	.718	.085	.539	.064
3. Educ. (2)	1.805	.639	.179	.063

Analysis of Variance

Source	$\underline{SS}$	$\underline{df}$	$\underline{MS}$	$\underline{F}$
Regression	13823.51	3	4607.835	48.161
Error	12916.26	135	95.676	

Table 38

Stepwise Regression Analysis: I
Criterion: Written Test I
(Step 4)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	9
Residual Variance	94.691	Predictor Entered	5
Residual S. D.	9.731		
Std. Error of Mean	.825		
Multiple R	.725		
Multiple R^2	.525		
Shrunken R^2	.515		
Constant (Intercept)	-59.000		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Attit-2 (6)	.778	.196	.273	.069
2. Attit-1 (5)	.158	.102	.107	.069
3. Pred. (4)	.708	.085	.531	.063
4. Educ. (2)	1.756	.637	.174	.063

Analysis of Variance

Source	SS	df	MS	F
Regression	14051.12	4	3512.781	37.097
Error	12688.59	134	94.691	

Table 39

Stepwise Regression Analysis: II
Criterion: Performance Test I
(Step 1)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	9
Residual Variance	114.207	Predictor Entered	4
Residual S.D.	10.687		
Std. Error of Mean	.906		
Multiple R	.600		
Multiple R^2	.360		
Shrunken R^2	.360		
Constant (Intercept)	2.370		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Pred. Score (4)	.765	.087	.600	.068

Analysis of Variance

Source	SS	df	MS	F
Regression	8801.115	1	8801.115	77.063
Error	15646.36	137	114.207	

Table 40

Stepwise Regression Analysis: II
Criterion: Performance Test I
(Step 2)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	9
Residual Variance	103.951	Predictor Entered	5
Residual $S.D.$	10.196		
Std. Error of Mean	.865		
Multiple R	.649		
Multiple R^2	.422		
Shrunken $\bar{R}^2$	.418		
Constant (Intercept)	-9.630		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Attit-1 (5)	.355	.093	.251	.066
2. Pred. (4)	.720	.084	.565	.066

Analysis of Variance

Source	SS	df	MS	F
Regression	10310.16	2	5155.080	49.591
Error	14137.34	136	103.951	

Table 41

Stepwise Regression Analysis: II
Criterion: Performance Test I
(Step 3)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	9
Residual Variance	100.994	Predictor Entered	6
Residual S. D.	10.050		
Std. Error of Mean	.852		
Multiple R	.665		
Multiple R^2	.442		
Shrunken $\bar{R}^2$	.434		
Constant (Intercept)	-23.530		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Attit-2 (6)	.448	.201	.165	.074
2. Attit-1 (5)	.242	.105	.171	.074
3. Pred. (4)	.711	.083	.558	.065

Analysis of Variance

Source	SS	df	MS	F
Regression	10813.32	3	3604.439	35.690
Error	13634.19	135	100.994	

Table 42

Stepwise Regression Analysis: III
Criterion: Time I
(Step 1)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	10
Residual Variance	126.765	Predictor Entered	4
Residual S. D.	11.259		
Std. Error of Mean	.955		
Multiple R	.680		
Multiple R^2	.462		
Shrunken $\bar{R}^2$	.462		
Constant (Intercept)	137.050		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Pred. (4)	-.997	.092	-.680	.063

Analysis of Variance

Source	SS	df	MS	F
Regression	14937.48	1	14937.480	117.836
Error	17366.81	137	126.765	

Table 43

Stepwise Regression Analysis: III
Criterion: Time I
(Step 2)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	10
Residual Variance	116.562	Predictor Entered	6
Residual S.D.	10.796		
Std. Error of Mean	.916		
Multiple R	.714		
Multiple R^2	.509		
Shrunken R^2	.506		
Constant (Intercept)	163.970		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Attit-2 (6)	-.682	.189	-.218	.060
2. Pred. (4)	-.961	.089	-.656	.060

Analysis of Variance

Source	SS	df	MS	F
Regression	16451.94	2	8225.970	70.571
Error	15852.43	136	116.562	

Table 44

Stepwise Regression Analysis: III
Criterion: Time I
(Step 3)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	10
Residual Variance	115.641	Predictor Entered	7
Residual $S.D.$	10.754		
Std. Error of Mean	.912		
Multiple R	.719		
Multiple R^2	.517		
Shrunken $\bar{R}^2$	.510		
Constant (Intercept)	153.530		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Writ-Time (7)	.114	.079	.089	.062
2. Attit-2 (6)	-.687	.188	-.217	.060
3. Pred. (4)	-.930	.091	-.635	.062

Analysis of Variance

Source	SS	df	MS	F
Regression	16692.92	3	5564.308	48.117
Error	15611.40	135	115.641	

Table 45

Stepwise Regression Analysis: IV
Criterion: Pass/Fail I
(Step 1)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	11
Residual Variance	.095	Predictor Entered	4
Residual S.D.	.308		
Std. Error of Mean	.026		
Multiple R	.430		
Multiple R^2	.185		
Shrunken $\bar{R}^2$	.185		
Constant (Intercept)	-.560		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Pred. (4)	.014	.003	.430	.077

Analysis of Variance

Source	SS	df	MS	F
Regression	2.950	1	2.950	31.078
Error	13.003	137	.095	

Table 46

Stepwise Regression Analysis: IV
Criterion: Pass/Fail I
(Step 2)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	11
Residual Variance	.092	Predictor Entered	6
Residual S. D.	.303		
Std. Error of Mean	.026		
Multiple R	.468		
Multiple R^2	.219		
Shrunken $\bar{R}^2$	.213		
Constant (Intercept)	-1.070		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Attit-2 (6)	.013	.005	.185	.076
2. Pred. (4)	.013	.002	.410	.076

Analysis of Variance

Source	SS	df	MS	F
Regression	3.489	2	1.744	19.033
Error	12.464	136	.092	

Table 47

Stepwise Regression Analysis: IV
Criterion: Pass/Fail I
(Step 3)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	11
Residual Variance	.091	Predictor Entered	8
Residual S. D.	.302		
Std. Error of Mean	.026		
Multiple R	.480		
Multiple R^2	.230		
Shrunken R^2	.219		
Constant (Intercept)	-1.520		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Perf-Time(8)	.007	.005	.110	.076
2. Attit-2 (6)	.013	.005	.183	.076
3. Pred. ((4)	.014	.002	.425	.077

Analysis of Variance

Source	SS	df	MS	F
Regression	3.676	3	1.225	13.475
Error	12.277	135	.091	

Table 48

Stepwise Regression Analysis: IV
Criterion: Pass/Fail I
(Step 4)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	11
Residual Variance	.090	Predictor Entered	7
Residual S.D.	.300		
Std. Error of Mean	.025		
Multiple R	.496		
Multiple R^2	.246		
Shrunken R^2	.229		
Constant (Intercept)	-1.290		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Perf-Time (8)	.008	.005	.137	.078
2. Writ-Time (7)	-.004	.002	-.130	.079
3. Attit-2 (6)	.013	.005	.181	.076
4. Pred. (4)	.013	.003	.398	.078

Analysis of Variance

Source	SS	df	MS	F
Regression	3.919	4	.980	10.909
Error	12.034	134	.090	

Table 49

Stepwise Regression Analysis: IV
Criterion: Pass Fail I
(Step 5)

Regression Factors	Statistics	Selected Measures	Variable
(Sample N)	(139)	Criterion Used	11
Residual Variance	.089	Predictor Entered	1
Residual S.D.	.299		
Std. Error of Mean	.025		
Multiple R	.507		
Multiple R^2	.257		
Shrunken $\bar{R}^2$	.235		
Constant (Intercept)	-1.120		

Variable(s) Selected	b Coef	b Std. Error	B Coef	B Std. Error
1. Perf. Test Time (8)	.009	.005	.151	.078
2. Writ Test Time (7)	-.003	.002	-.119	.079
3. Attit 2 (6)	.014	.005	.204	.077
4. Pred. (4)	.013	.003	.398	.078
5. Age (1)	-.016	.011	-.111	.078

Analysis of Variance

Source	SS	df	MS	F
Regression	4.102	5	.820	9.207
Error	11.851	133	.089	

VITA

Alexander A. Longo, born in Johnstown, Pennsylvania on September 5, 1935, is currently Chief of the Evaluation and Studies Office, U.S. Army Training Support Activity, Fort Eustis, Virginia. He received this position after relocating from Fort Monmouth, New Jersey in July 1975 where he served as Research Psychologist for 7 years.

He attended schools in Johnstown, and Brea California, and graduated from high school in 1953 at Del Amo Junior Seminary, Compton, California. He attended Loyola University, Los Angeles, where he graduated in 1958 with an A. B. in General Psychology. He then pursued graduate work at Fordham University, New York, where he graduated in 1960 with an M. A. degree in Experimental Psychology. He also did extended graduate work in Psychology at the New School for Social Research, New York.

His professional career included membership in the Naval Medical Service Corps in which he served as: Aviation Research Psychologist (Ensign) at the U. S. Naval School of Aviation Medicine, NAS, Pensacola, Florida (1960-62); and, (Lieutenant) at Naval Air Technical Training Command, NAS, Memphis, Tennessee, (1963-66). Subsequently, he served as Research Psychologist at the U. S. Military Academy, West Point, New York (1966-68); and, then was appointed as Chief, Evaluation Division of the U. S. Army Computerized Training Project, Fort Monmouth, New Jersey (1968-75).

He is married to the former June Carolyn Bishop of Pensacola, Florida and is the father of three children, Alexander, (13); Charles, (12); and, Darryl, (8).